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The potential for sustainable business model innovation: a case study of the airport retail sector in a low-carbon society.

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Thesis submitted in partial fulfilment of the requirements of the Manchester Metropolitan University for the degree of Doctor of Philosophy

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Declaration

No part of this work has been submitted for the award of a qualification at this or any other institution.

Signed,

Graeme Heyes

Abstract

The sustainability of the current economic system is coming under question, because of its continued reliance upon carbon fuels and their consequential impact upon the world's climate, and because levels of consumption are growing. Nowhere is this more apparent than in the retail sector, and in particular for airport retailing. Airport retail represents a vital revenue stream for airport operators, yet faces the challenge of being part of an industry that is itself under increasing pressure due to its significant and growing energy use and CO_2 emissions.

This research considered sustainability challenges arising from current patterns of consumption. It investigated environmental threats posed to the sustainable development of the airport retail sector, and its ability to adapt to a low carbon economy, via case study analysis of the World Duty Free Group (WDFG). It also identified the incumbent business model of the organisation using the 'Business Model Canvas[1]'. It quantified the carbon impact arising from airport retailing, finding that emissions arising from products sold being carried onto aircraft were greater than those arising from the outlets themselves. Finally, it assessed the suitability of emerging 'sustainable business model archetypes'[2] to meet the sustainability challenge faced by WDFG.

The research found that airport retailers are constrained by the commercial, operational and regulatory aspects of the airport setting, which result in higher levels of energy use and emissions but also makes them more difficult to manage. It found that WDFG is a successful example of an airport retail concessionaire whose success results from the fact that it is highly specialised. This very specialisation makes it difficult for the organisation to implement emerging sustainable business models. However, proactively adopting some of these principles could differentiate WDFG from others in the sector thereby enhancing its longer-term growth.

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[1] Developed by Osterwalder and Pigneur (2010)
[2] Described by Bocken *et al.* (2014)

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Acronyms

ACA	Airports Council International
ACI	Airport Council International
ATAG	Air Transport Action Group
BMC	Business Model Canvas
BSI	British Standards Institution
CAA	Civil Aviation Authority
CATE	Centre for Aviation Transport and Environment
CCC	Committee on Climate Change
CDC	Central Distribution Centre
CO2	Carbon Dioxide
CO2e	Carbon Dioxide Equivalent
CSA	Comprehensive Strategic Analysis
CSR	Corporate Social Responsibility
DEFRA	Department for Environment, Food and Rural Affairs
DFE	Design for Environment
DfT	Department for Transport
EC	European Commission
EU	European Union
FAA	Federal Aviation Authority
GBP	Great British Pound
GDP	Gross Domestic Product
GHA	Global Hectares
GHG	Greenhouse Gas
HSE	Health Safety and Environment
IATA	Intentional Ait Transport Association
ICAO	International Civil Aviation Authority
ICCT	The International Council on Clean Transportation
IPCC	Intergovernmental Panel on Climate Change
ISO	International Organization for Standardization
JAA	Joint Aviation Authorities
LCA	Life Cycle Environment
LCC	Low Cost Carriers
LED	Light Emitting Diode
MFnc	Mass Fuel Not Consumed

MFRes	Mass Reserve Fuel
MFTank	Mass Tankered Fuel
MMF	Mass Mission Fuel
MMU	Manchester Metropolitan University
MP	Mass Payload
MTO	Mass at Take Off
MZF	Mass Zero Fuel
OECD	Organisation for Economic Co-operation and Development
OEM	Operational Empty Weight
PAS	Publicly Available Specification
RPK	Revenue per Passenger Kilometre
RSS	Rich Site Summary
SA	Sustainable Aviation
SDC	Sustainable Development Commission
TBL	Triple Bottom Line
TQEM	Total Quality Environmental Management
UK	United Kingdom
UN	United Nations
UNFCC	United Nations Framework Convention on Climate Change
US	United States
WBCSD	World Business Council for Sustainable Development
WCED	World Commission on Environmental and Development
WCED	World Commission on Environment and Development
WDFG	World Duty Free Group
WRI	World Resources Institute
WSJ	Wall Street Journal
WTT	Well To Tank
WWF	World Wildlife Fund

1. Introduction

"…we'll be asking how we find new business models and keep developing our revenues while facing the challenges and disruptions of today"

Olivier Jankovec, Director General, Airports Council International (ACI) Europe, speaking about the agenda of the 24th Airport Commercial and Retail Conference and Exhibition, held in April 2015 (Moody, 2015)

This dissertation discusses the sustainability challenges encountered by airport retailers - via case study analysis of World Duty Free Group - as they operate in the aviation sector, both currently and in the future. This chapter sets out some of the motivating reasons and academic background for this research project (Section 1.1), before setting out the Research Problems and Objectives (Section 1.2), and Research Ambitions (Section 1.3).

1.1 Background

Two major themes that have characterised the development of human society and the global economy over the past century include: the growth of consumerism (Jackson, 2008) and of global mobility (Hooper, Raper and Thomas, 2010). These are directly linked to industrialisation and the development of the internal combustion engine, both powered primarily by carbon fuels. This has delivered significant socio-economic benefits for society; however, the emergence of the related issues of peak oil and climate change mean that the current economic system and societal structure that have resulted from these developments are, in their current form, unsustainable.

The idea that the climate is changing and that anthropogenic influences are the dominant force behind this has been demonstrated beyond reasonable doubt (Doran and Zimmerman, 2009; Stern, 2006; IPCC, 2013). Governments have responded by seeking to limit the impact of climate change to no more than 2°C above pre-industrial levels to stop potentially catastrophic changes to the Earth's climate (IPCC, 2007a; UNFCC, 2009). In the UK for example, the Climate Change Act (UK Government, 2008) requires an 80% reduction in carbon dioxide (CO_2) emissions over the period 1990-2050 to avoid 'dangerous climate change'. The scale of this challenge is great. A recent analysis by PricewaterhouseCoopers has found that an annual global decarbonisation rate of 5.1% is required to limit average annual temperature increase to 2°C, which is significant because the global average reduction since the year 2000 has been just 0.8% (PwC, 2012). Therefore, in order to meet reductions targets, transformative changes are required from all actors in society, from government, to the individual actions of the public, and the activities conducted by businesses.

Concurrently with climate change, economic growth has seen the demand for oil, and other finite fossil fuels, give rise to the concept of 'peak oil', in which the global production of oil has reached its peak, and will subsequently begin to fall (Sorrell *et al.* 2010). The significance of this is that the energy source that has driven the industrial revolution, and that plays such a significant role in modern society, will become a dwindling resource over the coming half century. This poses a significant threat to modern industrial and economic systems that, as with climate change, will require a radical scale of change - in this case towards industrial and economic systems that rely on alternative, renewable sources of energy.

The challenge of overcoming these issues whilst maintaining economic growth is encapsulated by the notion of Sustainable Development. This concept has been considered from a variety of different perspectives by governments, industry, academics, and NGOs (Upham, 2001a). From an environmental perspective, sustainability regards the maintenance of important environmental functions (Ekins and Simon, 1999) for present and future generations. This is perhaps best captured by the Brundtland Commission (WCED, 1987) definition of the concept as "*development which meets the needs of the present without compromising the ability of future generations to meet their own needs".* Providing more granularity, The Natural Step, an international network of NGO's, defines a sustainable society as one in which nature is not subject to systematically increasing:

- concentrations of substances extracted from the earth's crust;
- concentrations of substances produced by society;
- degradation by physical means.

Additionally, in that society:

- Human needs are met worldwide (Natrass and Altomare, 1999).

This perspective addresses both the concept of limited resources, environmental impact and social equity at a global level, but it is rigid in establishing environmental criteria as the principal limits to growth. It is through this context that the emergence of climate change and recognition that we are approaching or have reached 'peak oil' indicates that our current system is environmentally unsustainable.

The aforementioned 80% CO_2 reduction target will be challenging for all sectors of the UK economy. Some will be able to adapt and change, but others will find it especially difficult. The aviation industry is one sector that is particularly exposed to the challenges of sustainable development, both politically and commercially. The sector is heavily reliant upon carbon fuels and there is limited potential for technological improvement, so aircraft fuel consumption is forecast to grow. As a result, airline carbon emissions are predicted to rise at a time when governments seek a massive reduction in CO_2 across the economy. This suggests that aviation will remain in the political spotlight for the foreseeable future and against this background, every sector of the industry will have to demonstrate action to minimise their CO_2 emissions. This is a major factor that underpins the motivation for this research.

While airlines may be unable to fully compensate for growth by reducing their carbon emissions, there are significant opportunities for airports to deliver absolute CO_2 reductions, despite traffic growth. Considering this, in the future it can be anticipated that governments may seek to limit carbon emissions from airports[3] and their business partners. The majority of aviation CO_2 emissions come from aircraft operations, with the remainder arising from ground transport access and airport terminal activities (FAA, 2005). Emissions associated with the operation of airport terminals arise mainly from passenger handling, but also activities that are not directly linked to the flying of aircraft, such as airport retail.

Retailing lies at the very heart of the modern consumption-based society that developed out of a requirement for economic growth following the Second World War (Cohen, 2004). This saw businesses begin to focus on the mass consumption

[3] This is already the case for example in Arlanda Airport, Stockholm, where the airport is subject to a CO_2 cap (Swedavia, 2013).

of products as they shifted from satisfying individuals' needs and concepts such as longevity, towards satisfying wants, and concepts such as 'planned-obsolescence' (Guiltinan, 2009). The result is what has been described as a 'take-make-waste society' in which society relentlessly extracts materials from the ground and manufactures products that may very quickly be returned to the Earth as waste (Jackson, 2009).

Airport retailing therefore represents a particularly interesting sector of the economy in the debate around sustainable development. The sector is a particularly popular part of the aviation experience with the travelling public; consequently, some airports market themselves upon the quality of their shopping experience (Freathy and O'Connell, 1998). Furthermore, the sector can be highly profitable and generate significant income streams for retailer shareholders, and airport operators (Graham, 2009).

It is logical to assume that airport retail is associated with the same emissions sources as high street retailing; for example in-store energy demands, and distribution of products through their supply chain despite the absence of literature on this in the specific area of airport retail - indeed, establishing if this is the case is one of objectives driving this research. Additionally however, a consequence of retailing in the airport is that passengers take products sold in retail outlets onto aircraft, resulting in increased weight, fuel burn and CO_2 emissions. In addition to the environmental consequences, this has economic implications for airlines in terms of additional fuel costs, emissions taxes or permits. Airline weight-reduction efforts are already affecting passenger baggage allowances and hand baggage restrictions and this in particular could have direct consequences for airport retail. Given the size of airport retail sales (c. US$36bn / annum globally) (Verdict, 2014), it is likely that the sector is having a measurable impact upon aircraft CO_2 emissions and airline fuel costs; however, there has been little research in this field to date. This is important as the combination of the profitability of airport retailing (for airport operators) and its unquantified but potentially significant carbon emissions means that there can be a direct conflict between airports commercial retail interests and its carbon reduction objectives.

In the context of climate change and peak oil, the longer-term sustainability of the airport retail sector in its current form may be vulnerable. This is because:

- It is adding to fuel consumption and carbon emissions to an industry that is in the political spotlight as a result of increasing emissions.
- The sale of products in airports is not essential to air transportation; such products could be sold in the high street thereby reducing the carbon impact of the industry.

Increasing pressure on the wider aviation sector means that retail is likely to eventually come under scrutiny in terms of its carbon implications, despite the fact that CO_2 emissions associated with airport retail may represent a comparatively small proportion of those from the industry as a whole. The result is that the sector faces pressure from two sides. Firstly, it is in a consumption-based industry (retailing) that is at its very heart of the Sustainable Development challenge. Secondly, it is based in a sector (aviation) that is a major contributor to large societal issues (climate change and peak oil) that also threaten its future growth. All of the above suggests a need to investigate the following:

- the complete impact of current airport retail business models for energy use and carbon emissions;
- the development of an alternative low carbon (sustainable) business model;
- the ability of a major organisation in the airport retailing sector to move towards a more sustainable business model.

Accordingly, this thesis investigates the above areas, through case study research with a large multi-national duty-free retailer ‘World Duty Free Group’.

1.2 Research aims and objectives

Considering the above, the research aim of this thesis may be expressed as:

“To investigate how airport retail business models will have to evolve in response to the challenges arising from climate change and peak oil.”

In order to meet this aim, a number of objectives have been set, as detailed in below:

Research Objective 1; Understand the incumbent business model of airport retailers and identify the characteristics that differentiate the sector from other forms of retailing.

Research Objective 2; Determine the environmental impacts and resulting economic costs of airport retailer business models for airport operators and airlines.

Research Objective 3; Clarify how the carbon emissions and fuel cost implications of airport retailers may threaten the sector in the future.

Research Objective 4; Identify what 'Sustainable Development' might look like for airport retailers.

Research Objective 5; Understand how airport retailer business models can be adapted to the demands of a low carbon society.

1.3 Thesis structure

Chapter 1 presents the background to the research, the rationale for undertaking it, and the aim and objectives. Chapter 2 provides a detailed literature review by first introducing the concept of sustainable development, and then discussing the role of business in meeting this societal challenge. The chapter goes on to introduce the role of business models and innovation in driving organisational change, with particular focus on the nascent field of *sustainable business model innovation*. It finishes by describing the specific research setting, doing so by introducing the aviation sector and the challenges posed to it by climate change and peak oil. Chapter 3 details the research methodology that grounds the study along with justification of the use of case study analysis and a multi-phase research process. Additionally it details and justifies the analytical approach used in the study (Comprehensive Strategic Analysis). Chapter 4 introduces the research participant and organisation that was the case study for the research, the World Duty Free Group (WDFG). It does so in some detail, describing the extensive approach taken by the researcher to engage with the company and to conduct initial data gathering. In Chapter 5 the WDFG business model is investigated through the use of the Business Model Canvas[4], to understand the activities undertaken by the company, how these differ from other forms of retailing, and the environmental impacts arising from these business activities. This is followed by Chapter 6, which quantifies such emissions, firstly through the impacts associated with on-the-ground activities conducted by the business, and secondly through the indirect impacts that arise because of products sold in WDFG outlets being taken onto aircraft. Chapter 7 synthesises and discusses the previous research phases through the Comprehensive Strategic Analysis Framework. This comprises three phases: 'Situation Analysis', with the aim of building a detailed picture of the operating environment facing WDFG; 'Fulcrum Analysis' in which the call to take action by the company is identified; and 'Solution Analysis' in which alternative, low carbon business models are considered. In doing so the chapter highlights the key findings of the research that inform on how the airport retail sector may best adapt to the challenges of climate change and peak oil so that it can continue to grow. The thesis closes by presenting conclusions and recommendations in Chapter 8. It reflects on the research and its contribution to knowledge regarding airport retail business models, the environmental and associated economic impacts that result from this model, and how the sector might be able to move towards a longer-term vision of sustainability.

1.4 Research ambitions

This research aims to make a significant contribution to knowledge in a number of areas that are both of social relevance, and which are relatively nascent academic fields.

- Business model research has been growing rapidly since the turn of the century, however sustainable business model innovation is a particularly new field that has generated only a small amount of literature, most of which has emerged in the past five years.
- Businesses are one of the main contributors to climate change and will be required to adapt in order for this challenge to be addressed. By focusing on the airport retail sector, this research will investigate the ability of businesses to respond to this challenge.

[4] A popular business model identification and innovation tool developed by Osterwalder (2004)

- Airport retail is particularly exposed to these threats and therefore represents a valuable area of study, particularly in light of the fact that the sector is currently un-researched in a sustainability context.
- Understanding the threats posed to this sector, and theorising how it may adapt to survive in a low-carbon world will be of interest to researchers and industry practitioners alike.

2. Literature review

2.1 Introduction

This Chapter defines the research problem in the context of the academic literature, by placing it into a historical perspective, and critically analyses the surrounding theory across five broad themes; Sustainable Development, Sustainable Business, Organisational Change, Retailing, and Airport Retailing. These themes comprise a 'sensitising framework' (Klein and Myers 1999) that introduce the researcher to literature that is relevant to the research problem, as illustrated in Figure 2-1 below.

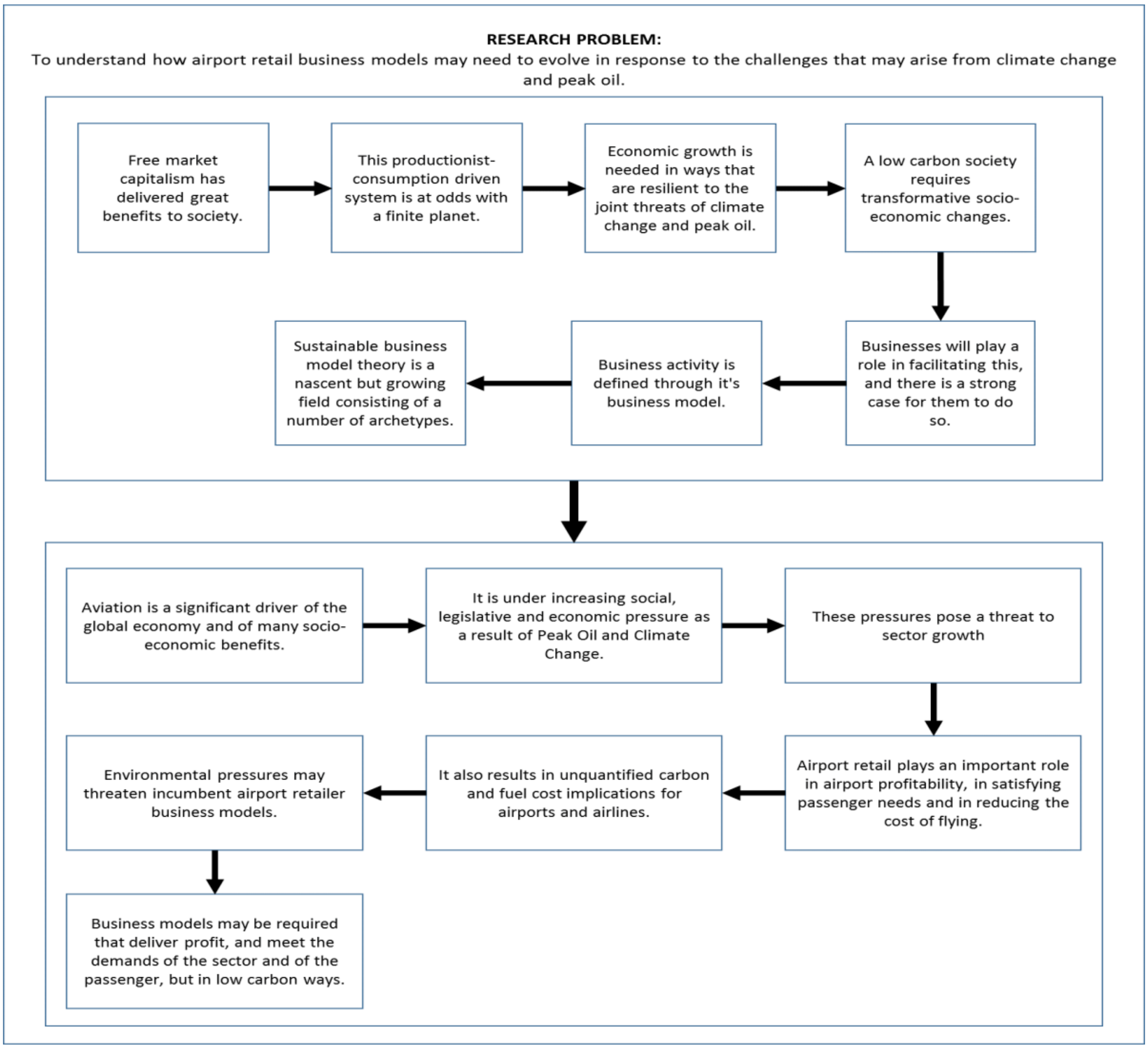

Figure 2-1; Sensitising framework of the present thesis.

The literature review begins by identifying and defining the incumbent capitalist economic system that governs most of the world's developed societies (Section 2.2), and how such a 'take-make-waste' system is incompatible with a planet with only a finite resource base (Section 2.3), a concept broadly defined as Sustainable

Development (Section 2.3.2). The role of businesses in meeting this challenge is outlined in Section 2.4, with businesses identified as being important actors in society that play a key role in the production and eventual consumption of resources. As such, businesses will play a huge role in meeting the challenges of Sustainable Development, and, as Section 2.4.2 shows, there is a business case for them to do so. The chapter then discusses how business may be able to adapt in order to meet this challenge (Section 2.5) and how such adaptations will be defined by their business model (Section 2.6), before discussing the concept of sustainable business models in general (Section 2.7). The chapter closes by introducing the case of the airport-retailing sector – an exemplar of the challenges thus far discussed (see Sections 2.8).

2.2 The environmental and global context for business

Throughout history, there has been a clear relationship between human, social and economic development, the environment, and business. The construction of infrastructure, ships, and the provision to industry contributed to deforestation and air pollution issues of ancient Rome (Tainter, 2006). More recently, economic growth brought on by the increased production potential of the industrial revolution brought about a significant step change in industrial activity and the way in which humans lived. This marked the end of agriculture as the primary means of employment in the United Kingdom (and later the rest of the World), and saw the rise of great industrial cities such as Liverpool, Manchester and London (Hudson, 1992).

With increased production however came increased environmental impact, for example water pollution and, significantly, local air pollution - leading to the Smoke Nuisance Abatement Acts of 1853 and 1856, and eventually to the Clean Air Act of 1956 (UK Government, 2015), to address pollution at a local level within urban conurbations. Over time, and with increased production from industry and associated growth of global economies, further issues would develop. Local air quality again become an issue for society in the large cites of the 1970s such as Los Angeles and Tokyo - with smog remaining a key environmental concern in modern day Beijing (Bridgman, 1990) – leading to additional regulations designed to reduce vehicle emissions and improve urban air quality.

Increasingly, society would begin to understand that economic growth had environmental implications that may lead to negative impacts on human health, quality of life and the wider environment. During the latter part of the 20^{th} Century, society would begin to see the global implications of human activity through the depletion of the ozone layer, and more recently through climate change. Environmental issues that were once local in nature were now recognised as having potentially global implications (see Meadows, 1972; Meadows, 1992), and there was a recognition that these issues have the potential to cause significant adverse effects upon human society, in terms of health and on the economy (Stern, 2006).

Today's world is largely governed by a capitalist system that is based on economic growth as the driver of 'progress' in which a substantial part of society's means of production is in private hands, rather than administered by Government (Jackson, 2009). The framework for this system was put in place in the early 1900s when the United States, and later the United Kingdom (following the Second World War), would encourage their citizens to consume as a way to help their economies recover from periods of national hardship.

"We must shift America from a needs to a desires-culture. People must be trained to desire, to want new things, even before the old have been entirely consumed. [...] Man's desires must overshadow his needs".

Paul Mazur, Harvard Business Review, 1927. Cited in Cohen (2004)

Such beliefs, fuelled by the theories of Edward Barnays – who applied the concepts developed by his uncle Sigmund Freud – would see a planned change in the marketing of products to the public, on the behalf of large American corporations (Brown and Vergragt, 2015). Rather than being promoted based on the traditionally important issues of functionality and longevity, products would instead be marketed to consumers based on concepts of individuality; ultimately leading to the creation of the profession of 'public relations' - a term phrased by Bernays himself (Brown and Vergragt, 2015). The result of such efforts would lead to a profound change in the relationship consumers had with the products and brands they purchased, and ultimately to the wholesale change in the consumption habits of the western economies that remains strong today.

The combined quest for economic growth from Governments, the work of Bernays, and the resulting desire for new goods and services from the general public, would lead to a ‘productionist’ paradigm of economic growth in which the manufacture and consumption of goods has been the dominant force behind government economic strategies (Martinez-Alier *et al.,* 2010). Jackson (2009) illustrated this approach, as seen in Figure 2-2 below, through a system described as ‘the circular flow of the economy’. That is (ibid:90):

“Firms employ labour (people) and capital (buildings and machinery) to produce the goods and services that households want and need. Households (people) offer up their labour and capital (savings) to firms in exchange for incomes. Revenue from the sale of goods and services is what allows firms to provide people with incomes. People spend some of this income on more consumer goods. But some of it they save. These savings are invested (directly or indirectly) back into firms”

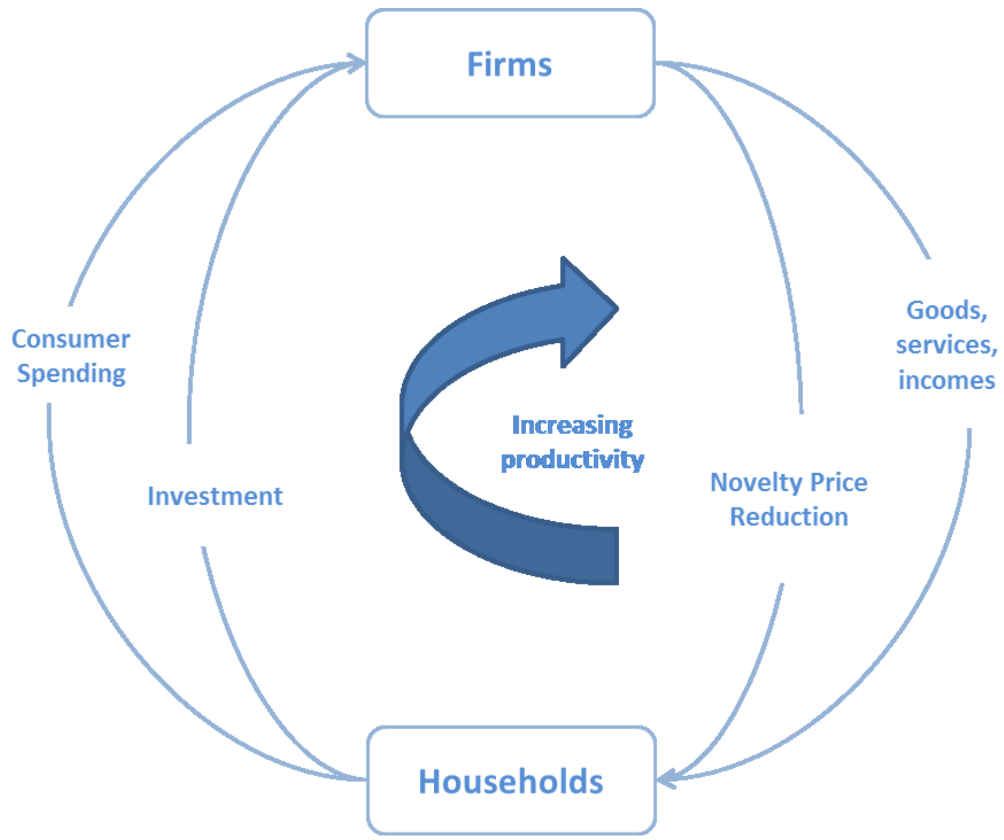

Figure 2-2; The Engine of Growth (Jackson, 2009)

In this way, the continued production of goods by firms, and their subsequent consumption by individuals, enables the economy to grow, for individuals to become wealthier (through employment or investments), and for needs to be met (through novel goods and services). With consumption central to this system, products are marketed on concepts such as fashion and newness, rather than longevity, with many products designed following the concept of planned obsolescence and volume of throughput a higher priority to manufacturers than quality (Jackson, 2009). The success of this system would see unparalleled changes to the world in which we live. The world would witness unprecedented economic growth, with continuous developments in technologies leading to vast improvements in manufacturing and labour productivity. The world's population would too grow, and people would gain access to goods and services not previously available. This would improve the quality of life for all who had access to such amenities – albeit, as discussed later in this chapter, a consequence of this was the increased consumption of limited resources, and the growing accumulation of wastes.

The dominance of capitalism and the creation of the corporation[5] would see a change in the way businesses operate, moving from sustainable, localised scales of production, to globalised systems entrenched in the capitalist doctrine of private ownership, and of operating strictly for profit (Bakan, 2004). Indeed, in some countries, for example the United States, a corporation is bound by law to maximise returns for its shareholders, no matter the consequences for externalities such as the environment, local communities and even its own employees (Bakan, 2004). With this legal focus on profitability, the corporation has effectively become an 'externalising machine' (Bakan, 2004) in which businesses often operate free from value judgements or external influence (Tisdel and Hartley, 2008). The firm's behaviour is bound only by the needs of the free market, and through regulations set by government that ensure the concerns of the wider society are accounted for (Tomer, 1999; Tisdel and Hartley, 2008; Keller, 2007). Societal issues that do not contribute directly to shareholder value are seen as an inconvenient and often a costly barrier to corporate growth and profitability (Tomer, 1999). The result being that externalities are dealt with by other institutions: be them governments (typically through taxation, regulation and penalties for non-compliance), or by non-governmental organisations such as charities (that may

5 A large company or group of companies authorised to act as a single entity and recognized as such in law.

perform public services that account for the socially negative actions carried out by firms), and consumers who may exert their influence through their purchasing power. This has resulted in firms traditionally viewing regulations as obstacles to current business practice and as additional costs. In turn, this has led to 'resistant adaptation strategies' (Fischer and Schot, 1993; Smith, 2009) that have gone as far as lobbying against such initiatives, and opposing such regulations through litigation (Geels and Penna, 2015). Indeed, renowned economist Milton Friedman (1962) famously made the argument that pro-social activities go against the very nature of the free market and the goal of profitability, stating that:

"there is one and only one social responsibility of business – to use its resources and to engage in activities designed to increase its profit so long as it stays within the rules of the game, which is to say, engages in open and free competition without deception and fraud"

(Friedman, 1967).

This 'short-term, profit maximising' relationship (Tomer, 1999) can be seen as defining the neo-classical model of the firm (Key, 1999; Stormer, 2003; Schumacher, 1974), as illustrated in Figure 2-3. Here businesses are understood to have perfect knowledge on which they base their decisions, doing so in order to maximise current period profit (see Richardson *et al.*, 1982). As a result, social and environmental issues are often a secondary concern compared to the primary goal of creating economic value (Stubbs and Cocklin, 2008).

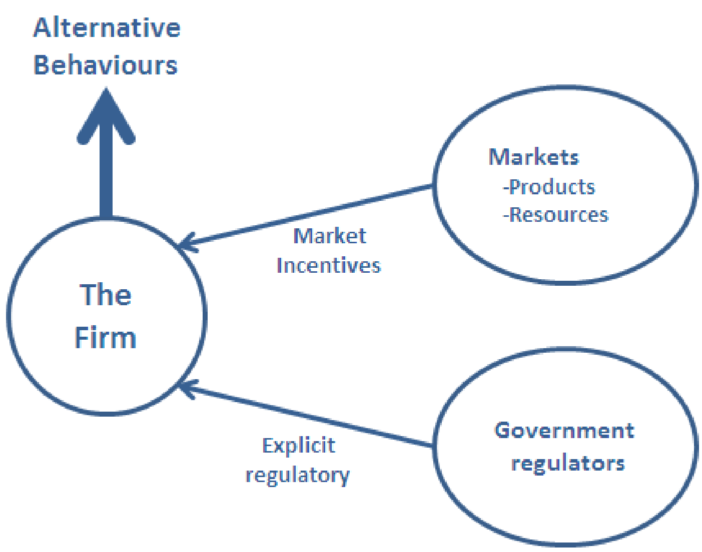

Figure 2-3; The Neo-Classical model of the Firm (Tomer, 1999)

In this way, socially responsible actions are deemed unacceptable unless they can provide some form of indirect benefit to the firm, in terms of its ability to generate profit; for example through an enhanced reputation that may appeal to a given market. Friedman goes on to say that firms should avoid philanthropic behaviour altogether as they lack the expertise in which to address such issues, nor do they have the right to decide what social actions are in societies' best interests:

"What business is it of the corporation to decide what's socially responsible? That isn't their expertise. That isn't what their stockholders ask them to do. So I think they're going out of their range and it certainly is not democratic."

Milton Friedman in The Corporation, 2003

According to Friedman, determining what business practices are acceptable should only be set through Government and their regulations, which are informed by a democratic process that represents the 'voice' of a nation. Managers who go beyond such regulations, Friedman argues, are acting immorally in that they are effectively spending shareholder money on activities that neither shareholders, nor the public, may agree with.

By the turn of the 21st Century however, the academic community, governments, NGO's[6], and even large organisations had begun to call such attitudes into question. These groups increasingly acknowledged the Earths limited (and dwindling) supply of natural resources, its ability to absorb modern levels of pollution, and the role of consumption based economies in driving these issues. The call for economic growth in ways that were sustainable was made and, the foundations of what would become to be known as Sustainable Development was made.

[6] Non-Governmental Organisations

2.3 The call for Sustainable Development

2.3.1 Critiquing the neo-classical model

In the context of the issues thus far discussed, the academic literature surrounding the idea that the incumbent economic paradigm is flawed, from an environmental perspective, began to build during the latter half of the 20th century; for example Silent Sprint (Carson, 1962), Limits to Growth (Meadows *et al.*, 1972), Small is Beautiful (Schumacher, 1974). The warnings detailed in such sources may be diverse, but the message they carried was consistent: the resource base for modern western lifestyles is dwindling at the same time as population, and demand for such lifestyles by the rest of the world is rising, resulting in an unsustainable burden. Firms are able to use collectively owned, and typically under or unvalued, natural resources (i.e. the atmosphere, watercourses and land) at will, and similarly may dispose of any harmful by-products of production within these resources, often without recourse. Consequently, they have less incentive to use fewer resources or produce less waste – as may be in society's best interest. Tomer (1999) describes this as a "negative externality problem", in that the social costs of the degradation of these resources are excluded from the firms' decision making process.

This problem is typified by the fact that despite economic growth over the past century, the world still faces a number of pressing social and environmental challenges. Today there are 1.4 billion people living in poverty (classified as those living on less than $1.25 a day), the poorest 40% of the world's population account for only 5% of global income, meanwhile the richest 20% account for 75% of the world's income (UN, 2009). Arguably, the people at the bottom of the economic pyramid (see Pralahad, 2004) will consume progressively more as they become more affluent – a growth in demand that might be expected to speed up as more of the world gains access to the internet and becomes aware of the lifestyles of the rest of the planet.

Despite such inequalities, levels of human consumption are exceeding the carrying capacity of the Earth. In 2005, the Earth's global ecological footprint, measuring humanity's demand on the biosphere in terms of the area of biologically productive land and sea required to provide the resources we use and to absorb our waste, was 17.5 billion global hectares (gha), or 2.7 gha per person (WWF, 2008). Given the incumbent technological, economic and political systems, this is some 30% higher than the global footprint the Earth can sustain (WWF, 2012). In addition, four out of the nine planetary boundaries[7] that humanity needs to survive, have been exceeded (Rockström, 2015). Thus, environmental issues have the potential to place, or are already placing, very real constraints on the global economy's ability to grow (and to alleviate poverty). A situation termed by Meadows *et al.* (1974) as *The Limits to Growth.* This therefore calls into question the validity of the circular flow of the economy to deliver prosperity 'in any meaningful sense' (Jackson, 2009). This concept is perhaps best illustrated through two pressing issues facing society; namely Peak Oil and Climate Change.

- *Peak Oil:* It is increasingly acknowledged that the last 100 years of economic growth has seen the demand for oil, and other finite carbon fossil fuels (such as coal and natural gas) grow at such a rate that we are now consuming these resources at a greater volume than they are being discovered, extracted and refined. This situation is known as 'Peak Oil', a term first coined by M. King Hubbert (Hubbert, 1956), to describe the situation where the demand for oil exceeded the point at which new reserves were being discovered. As existing reserves continue to fall, previously marginal, expensive, and technically difficult sources of fuels have become more viable options for oil companies; even at the potential cost of increased environmental impacts[8]. All of this has seen the cost of oil rise exponentially in recent decades, with significant implications for every sector of the economy. In the short-term, operating costs for those businesses who rely on such resources are rising, whilst in the longer-term, the future availability of oil may be called into question. Other energy sources, such as nuclear or solar, represent viable options for many sectors; for others – such as aviation – this is not the case. As such, Peak Oil represents a challenge for the aviation sector, and all actors will be required to play a role in helping the sector to adapt.
- *Climate Change:* Concurrent with the challenges posed by peak oil, there is a growing concern about increasing emissions of Greenhouse Gases

7 A central concept in an Earth system framework that defines a "safe operating space for humanity" (see Rockström, 2015).
8 See for example the recent discourse on Fracking (BBC, 2013).

(GHGs) that result from human activity[9], and their influence on the Earth's climate (IPCC, 2014). Indeed, 97% of published climatologists believe that climate change is occurring as a result of human influence, whilst, between 1993-2003, not a single peer-reviewed academic paper on the subject of 'global climate change', rejected this consensus opinion (Cook *et al.*, 2013). The potential impacts of this on the planet are great, for example global increase in average temperature, increase in extreme weather events, and rising sea level. Likewise, the consequences of this for society are numerous, not least; changing patterns of food production, flooding of low lying areas, and resulting mass migrations of populations across the planet. The economic impact of this is calculated as between 5-10% of global Gross Domestic Product for global warming of between 5-6% (albeit some climate predictions exceed this temperature increase) (Stern, 2006). In a commitment to tackle climate change, the worlds governments agreed to prevent global temperature rise to no more than 2 degrees Celsius at the 1997 United Nations Framework Convention on Climate Change (Grubb, Brack and Vrolijk, 1999), committing to reduce global Carbon Dioxide (CO_2)[10] emissions by 50% in order to achieve this aim. To meet to this objective, the United Kingdom committed in the 2008 Climate Change Act to reduce its emissions by some 80% by 2050 (UK Government, 2008). Clearly, these ambitious targets will require collective action by every sector of the economy – and have significant implications for any industries that fail to, or are unable to, act.

The challenges of Peak Oil and Climate Change are issues that have resulted from a 'take-make-waste' economic system, occurring on a planet of finite resources and carrying capacity for environmental harm (Hawkden, 2010). In part, the peak oil challenge arose from the huge reliance of the global economy upon carbon fuels and the low price of energy during much of the 20th Century, which led to profligate use and a failure to drive eco-efficiency through the system. Likewise, the problem of climate change arose due to the direct link between economic development and the burning of fossil fuels and the failure of the market

[9] Predominantly arising from the combustion of fossil fuels used in industry, transportation, and energy.
[10] A key Greenhouse Gas - discussed further in this thesis.

to internalise the environmental and social damage that has arisen as a result (Jackson, 2009).

Clearly, there is a need for such a system to be reconfigured if the social and economic benefits that capitalism provides society may be continued into the long term. There is a need for the economic system to recognise the fact that we live in a society faced with dwindling resources (Meadows *et al.,* 1974), a planet in which many of the world's ecosystems are in a state of decline (Rockström, 2015), and where climate change represents "humanities greatest challenge" (UN, 2014). It must do this at a time when the economic system is increasingly unstable (WSJ, 2015), and although levels of poverty may be falling (World Bank, 2013), levels of inequality between the richest and poorest members of society are growing (Jackson, 2009). As a result, the advocacy of a 'business as usual' approach to the economy has understandably been called into question. That global population is projected to surpass 9 billion by 2050, and the population of developing nations expected to rise from 5.6 billion in 2009 to 7.9 billion during the same period (UN, 2009), implies that these pressures are only likely to increase.

It is now considered that we have transitioned into a 'human-dominated geological epoch'[11] (Lewis and Maslin, 2014), in which the impacts humankind has on the environment are diverse and global in nature. Resource constraints and imbalances in supply and demand are likely to result in large fluctuations in commodity prices that may destabilise businesses and customers alike (Wells, 2013). At worst, limited accessibility to certain resources may be absolute and could act as a cap on production of certain goods. For example, China is already stockpiling certain materials and natural resources in order to secure its own industry in the future (Wells, 2013), rather than exporting them for profit.

The issues described above are illustrative of a market failure in the economy: the Earth's finite supply of natural resources is getting depleted, and there is, at present, little market incentive for firms to change their behaviour. Indeed, the Stern Review (2006) supports this notion, stating that the failure to place a value on the natural environment (e.g. the climate system), and to internalise, rather

[11] In which the influence of humanity on the planet have become so great that it is now the predominant driving force.

than externalise it, is the biggest market failure the world has ever seen. Likewise, Hawkden *et al.* (1999) describe the neo-classical way of doing business as not fully conforming to its own accounting principles, stating that it:

"liquidates its capital and calls it income. It neglects to assign any value to the largest stocks of capital it employs – the natural resources and living systems, as well as the social and cultural systems that are the basis of human capital".

Hawkden *et al*, 1999: 5

Natrass and Alltomare (1999) describe such businesses as "organisations-as-machine"; that is, businesses are designed to achieve very specific goals centred on profitability and operate as a network of parts towards achieving that goal – typically with a short-term focus. This approach has been successful in generating the economic growth that capitalism has provided, however, according to sustainability advocates; it is ill equipped to deal with the finite resources of the planet. Growth advocates such as Beckerman (1974) and Maddox (1972) argue against this point stating that human resourcefulness will enable humankind to overcome such obstacles. For example;

- Through the ability of the market to increases prices as supply falls and thus reduce demand;
- For exploration to open up avenues to previously 'uneconomic' resource sources (such as tar sands in the case of peak oil);
- And for innovation to enhance the efficiency of resource use or extraction, or to act as the driver for the development of alternatives.

The validity of such claims is supported by the fact that there is a historical precedent of their success (see Graedel and Allenby, 1995), however, it can be argued that such claims are limited on a number of levels, not least;

- The market currently does not value many environmental factors, such as the planets ability to absorb carbon, or the quality of local water courses;
- Extrapolation of previously uneconomical resources can be linked to risker environmental impacts; and,
- Whilst innovation is a powerful tool, there is no guarantee that innovation can or will occurring in perpetuity, or that innovations will not lead to further adverse environmental issues down the line.

If we are to accept that the current economic paradigm does have environmental failings, this begs the question as to what sustainable development might look like, an area to which we now turn.

2.3.2 Defining Sustainable Development

Increasing academic focus on the inadequacies of the neo-classical economic paradigm, coupled with increased awareness from the public, would see such issues addressed at the 1987 World Commission for Environmental Development (WCED) and in UN-sponsored 1987 report *Our Common Future,* commonly referred to as *The Brundtland Report*[12]*.* It was this landmark report that defined the concept of Sustainable Development in a way that would have a marked impact on the world, defining it as:

'…development which meets the need of the present without compromising the ability of future generations to meet their own needs'.

(WCED, 1987: p8)

The report identified seven critical objectives for Sustainable Development to be achieved. These highlight the requirement for economic growth as the means by which the world's societal and environmental challenges may be addressed – albeit it should be noted that specific targets and definitions of what Sustainable Development may look like are notably lacking (WCED, 1987: p49):

- Reviving economic growth;
- Changing the quality of growth;
- Meeting essential needs for jobs, food, energy, water and sanitation;
- Ensuring a sustainable level of population;
- Conserving and enhancing the resource base;
- Reorienting technology to manage risks;
- Merging environment and economics in decision-making.

Specifically the report says of economic growth:

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[12] In recognition of former Norwegian Prime Minister Gro Harlem Brundtland's role as Chair of the WCED.

'…Poverty is a major cause and effect of global environmental problems. It is futile to deal with environmental problems without a broader perspective that encompasses the factors underlying world poverty and international inequality.'

(WCED, 1987:1)

Natrass and Altomare (1999) take a different approach to sustainability by detailing four system conditions for sustainability, based on first-order principles[13]. The authors propose that defining sustainability in this way provides a logical starting point in making more sense of, and coordinating in a strategic way, the other, lower-order parts of the system. They state that for a society to be sustainable, nature's functions and diversity should not be:

1. Systematically subject to increasing concentrations of substances extracted from the Earth's crust;
2. Systematically subject to increasing concentrations of substances produced by society;
3. Impoverished by overharvesting or other forms of eco-system manipulation, and that;
4. Subject to inefficient and unfairly use of resources, in order to meet basic human needs worldwide.

Such holistic views of sustainability help to frame the concept of Sustainable Development in a social discourse, acting as a gathering force for the enmeshed social, cultural, environmental and economic issues present in everyday life (Wells, 2013). Furthermore, it is through these definitions that the main oxymoronic problem with the concept of Sustainable Development can be understood. In order to achieve true global equality, it is necessary for lesser-developed nations to develop, bringing the quality of life of their citizens into balance with more developed nations; however, the economic growth required for this development is, in its current state at least, unsustainable, due to resource and environmental implications. This suggests that lowering levels of consumption in more developed economies may be required in order to achieve some level of convergence in global quality of life – unless significant changes are brought about in the way products and services are manufactured, delivered, consumed and

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[13] The core principles that define an object or system.

disposed of by individuals. Both of these options would require significant socio-technological transformations in society and so are likely to prove difficult to facilitate.

Today the global economy is almost five times its size of 50 years ago; this increase has no historical precedent and is at odds with our understanding of the finite resource base and fragile ecology on which we depend for survival (SDC, 2009). The challenge of delivering economic development whilst protecting the environment is great and - according to former Secretary-General of the United Nations (UN), Kofi Annan - our biggest challenge; one that takes *“an idea that sounds abstract – sustainable development – and turns it into reality for all the world’s people”* (Kofi Annan, 2001; cited in Fien *et al*. 2009).

2.4 The practicalities Sustainable Development

In response to the need for sustainable development and the specific global threat of climate change, the world's governments have set a suite of CO_2 reduction targets. For example, an agreement at the United Nations Framework Convention on Climate Change at Copenhagen 2009, was made to limit climate change to a global temperature increase of no more than 2 degrees Celsius, so to avoid catastrophic environmental impacts for humankind (UNFCC, 2009). Achieving such targets will require vast improvements in the decarbonisation of the world's economy, with Jackson (2009) stating that this would require an annual reduction in the carbon intensity of the global economy of 9% per year, every year, until 2050. According to Jackson (2009) however, carbon intensities of the global economy have declined by just 0.7% since 1990.

This conclusion was also illustrated via a more recent study conducted by PricewaterhouseCoopers which found that an annual decarbonisation rate of 5.1% is required to limit average global temperature increase to $2^{o}C$, but that the global average since the year 2000 has been just 0.8% (PwC, 2012)[14]. In terms of consumption, there is an equally difficult and complex challenge, with the United Nations defining the search for 'Sustainable Consumption' as:

"The use of services and related products which respond to basic needs and bring a better quality of life while minimising the use of natural resources and toxic materials as well as emissions of waste and pollutants over the life cycle of the service or product so as not to jeopardise the needs of future generations"

UN Commission on Sustainable Development, 1994

Monaghan (2012) discusses the scale of this challenge, albeit in the context of local government, noting that approximately 60% of global GDP is spent on consumer goods. If we consider that global population is expected to increase to 9.6 billion by 2050, and global GDP is set to rise by 325% during the same time period (WBCSD, 2008), it is possible to appreciate the amount of additional natural resource extraction, energy use and material production that is likely to result

[14] The difference between the 9% and 5.1% targets recommended in each of these reports is due to the former including a growing population, and growing economy, whereas the latter does not.

through the current economic system. Clearly, the current trajectory of society is incompatible with the notion of 'one-planet living' (WWF, 2015) and will require significant changes in society; from the way in which governments govern, businesses do their business, and the way the public live their lives. Jackson (2009) describes this as the idea of 'prosperity without growth', that is; meeting the requirement of Sustainable Development to raise societal quality of life, but doing so in such a way that the global economy and resource use are de-coupled in terms of material production, consumption and the environmental impacts that result. How this challenge may be overcome is a matter of some dispute in the literature.

In the United Kingdom, two leading environmental commentators – Jonathan Porritt and George Monbiot - have differing opinions on this challenge. Porritt (2007) states that population control is the best way to reduce the impact of future consumption, since it is the most cost-effective way of doing so[15]. Monbiot (2006) however argues differently, stating that the problem of consumption is based on the excessive lifestyles of wealthy societies rather than population:

"people might populate less as they become richer, but they do not consume less; rather, they consume more. That is, as the habits of the super-rich show, there are no limits to human extravagance".

Monbiot, Heat, 2006

This view is supported by Satterthwaite (2009) who uses the fact that between 1980 and 2005, sub-Saharan Africa represented 18.5% of global population growth, but only accounted for an increase in CO_2 emissions of 2.4%, due to the fact that patterns and levels of consumption in such areas hardly changed in this period. The scale of this is further represented by the fact that 63% of global population increase to date has occurred in areas of very low emissions per capita. Rather than relying solely on population control, Monbiot discusses the power of efficiency improvements and behavioural change as ways in which economic and social activity may be reconfigured towards a more sustainable society. This is a popular view espoused by a number of leading sustainability

15 Wire (2009) for example demonstrated that a spend of US$6 on contraception may result in a saving of 1 tonne saving of CO2, whilst tree planting (US$12), wind power (US$22.5) and solar energy (US$84) represent much more costly means of the same carbon reduction.

researchers who see society has having the ability to maximise material productivity in such a way that we are able to do much more with less, for example; Schumacher (1974), Hawken *et al.* (2005), Hawken (2009), Lovins and Cohen (2012), Natrass and Altomare (1999) and Weizsäcker *et al.* (1997). Indeed Hawken *et al*. (1999) describe increased resource efficiency as being the 'cornerstone' of any efforts to move towards sustainability aspirations.

Weizsäcker *et al.* (1997) suggest that such resource efficiencies have the ability to double global wealth whilst halving resource use - a 'factor four' improvement in productivity. This can be achieved by eliminating inefficiencies and wastage in modern economic systems, enabling society not only pollute and deplete less, but to also live better, make money, harness markets and enlist business, multiply use of scarce materials, and increase security. Schmidt-Bleek (2007) goes a step further by proposing that factor ten improvements in productivity might be achievable if a focus is made on material turnover, and that this level of efficiency may be actually be necessary in the light of increasing global population and the aim of raising global standards of living. Such efficiency approaches have the ability to drive growth, through the reduction of labour and resource inputs that may bring down the cost of goods over time, stimulating demand and growth as a consequence (Jackson, 2009). Clearly, this resonates with the concept of Sustainable Development, although the literature does warn about the rebound effect of such the eco-efficiency approach in that the increased demand that may arise as a result of lower costs may lead to even greater levels of consumption (see Sorrell, 2007). For example, an individual switching to energy saving light bulbs may make an economic and environmental saving, but use the money saved for a holiday involving a long-haul flight –comparatively increasing the overall carbon emissions and natural resource extraction as a result. Thus, attaining sustainable patterns of consumption requires that people understand the environmental challenge facing society, and how their behaviour contributes to it in a democratic society, an issue explored in greater detail by the likes of Penna and Geels (2012).

Enhanced eco-efficiencies are useful in that they enable the current economic system to be largely maintained, i.e. to still provide the public with products and services that they demand, and for businesses to stay profitable, but to do so in less resource intensive ways. Jackson (2009) discusses this as being a 'relative de-coupling'[16] of economic activity from environmental intensity, in that it has the ability to see environmental impacts fall relative to GDP (although it should be noted that if GDP rises, the overall environmental impacts of society may still increase).

There are, therefore, a number of ways in which economic growth could be compensated for through changes in patterns of consumption, in infrastructure, technologies and in the way in which services are delivered. The question remains however, whether such changes could be delivered in a free market, global economy, and whether individual companies can identify these long-term threats to their sustainable growth and take action to adapt their current business models.

2.4.1 The role of business

"Businesses are the main form of social organisation through which we collectively extract and use materials, and must therefore carry the burden of change or be displaced by some other form of social organisation"

Wells, 2013

As the main functional mediators between production and consumption (Wells, 2013), and with a particularly key role to play in terms of eco-efficiencies, businesses will be key in meeting the challenges so far discussed, for "*if patterns of production and consumption define the character and scale of sustainability challenges, then businesses embody the critical interface between the two"* (ibid:1). Building on the work of Jackson (2009), Bocken *et al.* (2014:43) suggest a number of features that may form the basis of a sustainable economy. From these it is clear that they are not directly compatible with the profit-centric, short-term, externalizing approach to businesses adopted by many organisations:

- A system that encourages minimising consumption, or imposes personal and institutional caps or quotas on energy, goods, water, etc.;
- A system designed to maximise societal and environmental benefit, rather than prioritising economic growth;

16 The alternative approach is an absolute de-coupling of economic activity and resource intensity, a rather more ambitious approach that sees resource impacts being so far removed from economic activity that they stay stagnant or fall, regardless of economic or industrial activity.

- A closed-loop system where nothing is allowed to be wasted or discarded into the environment, which reuses, repairs, and re-makes in preference to recycling;
- A system that emphasises delivery of functionality and experience, rather than product ownership;
- A system designed to provide fulfilling, rewarding work experiences for all, and that enhances human creativity/skills.

Increasing awareness of sustainability issues, combined with increasing pressure from stakeholder groups such as Governments, NGOs, and the public have seen the 'green growth' policy agenda grow in today's business world (OECD, 2009; 2011). This has however occurred concurrently with the increasing recognition that technological innovation alone will not be enough to resolve all of our sustainability challenges, for efficiency improvements resulting from technology may not be able to keep up with increasing consumption and production from a growing and more prosperous society (Wells, 2013).

The ability of business to have a marked impact on the pursuit of Sustainable Development is perhaps best illustrated through economic long waves first identified by Nikolai Kondratiev in his book "The Major Economic Cycles" in 1925, and popularised by Schumpeter (1974), and later Freeman (1984). Historically, many hundreds or even thousands of years could pass with little or no technological change from humanity (Tainter, 1996). Since the industrial revolution of the British Isles in the 1800s however, innovation has risen to become an institutionalised process at the very core of modern western capitalism, with cycles of innovation and continuous introductions of new products and upgrades to existing ones (Tainter, 1996). In this way, the global consumption engine keeps turning and the world's economy is able to grow. The profits made from innovations act as a key driver in new surges of economic growth that subsequently act as a signal to other investors and imitating entrepreneurs to follow suit[17].

[17] A process known as the Diffusion of Innovations (see Everett,2003).

Such cycles have long been acknowledged in the literature, on a much larger scale, with the world's economic output moving through cycles of growth, and decline, driven by continuous technological innovation. These waves of innovation result from the reorientation of industrial organisation and management, based on technologies that underlie the existing economic cycle (Freeman and Perez, 1988). As illustrated in Table 2-1 below, it is widely acknowledged by proponents of this theory, that there have been five such Kondratiev waves to date, since the industrial revolution of the late 1700s (see for example Papenhausen, 2008; Freeman and Perez, 1984; Moody and Nogrady, 2010; Papenhausen, 2008). Each 'era' is associated with a number of step change innovations that typically gave access to, or required the use of, new resources - as well of the development of the way in which businesses operated.

As can be seen from these cycles, each wave can be categorised by some major, radical innovation that has enabled a reconfiguration of economies based on new, more productive, ways of doing things. Mass production for example did not see the creation of the automobile, rather it saw a new way of producing the automobile, in a way that was cheap and efficient and thus made the car affordable to most of society, in the process ushering in an age of distribution and mobility not previously seen. The same has been true of the development of air transport and global mobility and the consequences of this for new patterns of trade and migration, an issue that is revisited in Section 2.9. Each of the waves has seen an increase in human mobility, global sourcing of materials and distribution of goods and services, and of growing environmental impacts – both in terms of their scope and scale.

The idea of a 6th 'Green Wave' of innovation holds much opportunity for a new era of economic growth, based on a number of high-level sustainability concepts. These can empower businesses and individuals to do more with less (see Nogrady, 2010; Weizsacker *et al.*, 2009), with Kondratiev theory providing insight into how we may be able to de-couple from the relationship between economic activity and resource intensity, so as to deliver economic growth in a sustainable way. As Swilling (2013) states:

Table 2-1; Summary of Kondratiev Waves (After; Moody and Nogrady, 2010)

	Wave 1: Cotton, Iron and Water Power	Wave 2: Railways, Steam Power and Mechanisation	Wave 3: Steel, Heavy Engineering and Electrification	Wave 4: Oil, Automobiles and Mass Production	Wave 5: Information and Communication Technology
Upswing in Economic Growth	1780s-1815	1848-1873	1895-1918	1941-1973	1980-2001
Downswing in Economic Growth	1815-1848	1873-1895	1918-1940	1973-?	2001-?
Technologies	Cotton spinning and iron products, water wheels, bleach	Railways and railway equipment, steam engines, machine tools, alkali industry	Electrical equipment, heavy engineering, heavy chemicals, steel products	Automobiles, trucks, tractors, tanks, diesel engines, aircraft, oil refineries	Computers, software, telecommunication equipment, biotechnology
Core Inputs	Iron, raw cotton, coal	Iron, coal	Steel, copper, metal alloys	Oil, gas, synthetic materials	Integrated circuits
Transport and communications Infrastructure	Canals, turnpike roads, sailing ships	Railways, telegraph, steam ships	Steel railways, steel ships, telephone	Radio, motorways, airports, airlines	Internet, Information highways
Level of Impact (e.g. mobility, business structure, environmental impact).	Local → Global				

"It makes both conceptual and empirical sense to accept that if the appropriate politico-institutional reconfigurations emerge in response to a range of mounting but also unpredictable pressures (e.g. global agreements on carbon prices, biodiversity restoration, resource depletion and restructuring of global finance), the deployment phase of the Information Age (driven by productive capital) and the installation phase of the 'green-tech revolution' (driven by finance capital plus, possibly, broad-based civil society-cum-social enterprise economies organised around decentralised renewable energy systems) could well become the drivers of a sustainable global development cycle that results in improved (and ideally increasingly equitable) economic prosperity decoupling from rates of resource use".

(Swilling, 2013).

Weizsacker *et al.* (2009), identify three principle ingredients that may facilitate movement into a new sustainable economic long wave, all of which are present in society today;

1) ***Existing technologies/structures becoming obsolete through new technologies and processes.*** As well as typically being more efficient or practical than current technologies, new innovations are associated with novelty and due to usual high costs at inception, the notion of 'progress' and higher standards of living. The result is that their application can appear more attractive than existing systems.
2) ***Strong demand.*** Demand for a given innovation is also necessary for a new wave to be successfully brought into fruition. Clearly, an innovation that has no demand is less likely to be used, and thus have little or no impact on a global scale. New innovations are often associated with initial high costs, however as costs begin to fall, demand rises, fostering in the acceptance of the new wave.
3) ***Innovation itself.*** Although an obvious requirement, a new wave cannot begin without some innovation to fuel it. Innovations can take the form of technological advancements to new innovative ways of conducting business, such as product-service systems discussed previously.

Clearly, as drivers of consumption, production and of much innovation, the worlds businesses will play a role in delivering the transition to a sustainable society. Companies of all sectors will need to change the way in which they go about their business – to seek new ways of generating profit, through strategies that cause no net harm to the environment, or that even have restorative environmental capacities. This represents a step change in business activity and a complete reworking of the economic system. The challenge is great, but as discussed below there is a strong and growing business case for firms to adopt such approaches.

2.4.2 The business case for sustainability thinking

The business case for sustainability is somewhat equivocal (Wells, 2013), however the literature is increasingly leaning towards the view that sustainability principles are of benefit to firms. The case is broadly rooted in the concept that businesses are able to convert market imperfections[18] into business opportunities (Cohen & Winn, 2007), so as to 'do well' (economically), by doing 'good' (whilst being socially and environmentally responsible). Businesses are social institutions being heavily reliant on the public and natural environment, with their success or failure bound up in wider issues than the creation and capture of commercial value, (Wells, 2013). As such, the idea that pro-social activities such as those rooted in sustainability are good for business certainly has some philosophical grounds. Furthermore, the case for sustainability is increasingly borne out in the literature. King and Lennox (2001) state that it is not a question of whether it pays to be green, but rather 'when' it pays to be green.

Schaltegger *et al.*, (2011), developed a conceptual framework of the business case for sustainability, describing it as an "enlightened self-interest", where economic success is increased concurrently with the pro-environmental and social actions. The authors noted that "theoretical and empirical research indicates that most companies seem to have the potential for one or several business cases for sustainability", before going on to list three requirements for the sustainable business case to be realised by a firm (ibid:p8):

- The company must realise a voluntary, or mainly voluntary activity, with the potential to contribute to the solution of societal or environmental problems that go beyond regulatory conformance (doing so would simply be complying with minimal regulation and can be considered a business as usual approach).
- The activity must create a positive business effect that contributes to corporate success, which must be measurable - for example cost savings, or customer retention.
- A clear argument must exist that a certain activity has led, or will lead to both the intended societal or environmental impact, and the economic benefit to the firm.

They go on to describe six core drivers for the business cases for sustainability, and demonstrate typical corporate strategy regarding such drivers depending on

[18] Inefficient firms, externalities, flawed pricing mechanisms and information asymmetries (Cohen & Winn, 2007). Such imperfections can often be the driver of innovation as businesses look to take advantage.

whether firms have a defensive, accommodative, or proactive stance towards sustainability issues, as shown in Table 2-2. Defensive firms have a more reactionary approach to sustainability in which they look to maintain the present business strategy and structure, whilst minimising risks and costs posed by sustainability issues. Proactive firms on the other hand engage with the sustainability discourse, acknowledge the impact it may have on their business and look to embed sustainability thinking into their strategy so as to maximise potential gains. Rather than simply looking to minimise threats, they also look to find opportunities that may help them to grow.

Table 2-2; Interrelations between corporate sustainability strategies and business case drivers (Schaltegger *et al.*, (2011).

	Corporate Strategy		
Core drivers of business sustainability	Defensive	Accommodative	Proactive
Costs and cost reduction	Mainly cost and efficiency oriented compliance activities (often “low hanging fruit” only)	Cost and efficiency oriented activities actively pursued and linked to sustainability issues when possible	Cost and efficiency oriented activities actively created to achieve sustainability goals; cost concept includes external social costs
Sales and profit margin	Products or product communication are adapted to reduce risks of sales decrease	Sustainability-oriented customer segments are partly acknowledged and served with specific products (besides existing conventional product lines)	Market-oriented strategies to gain competitive advantage by making sustainability-oriented products and services become the core of the company’s portfolio.
Risk and risk reduction	Sustainability issues seen as sources of risk; activities aim at risk reduction (in contrast to precaution)	Sustainability and risk management seen as complementary and opportunity-creating concepts	Sustainability and risk management seen as complementary and opportunity-creating concepts; risk concept includes social risks
Reputation and brand value	Reputational activities, rather reactive and mainly oriented towards risk reduction	Sustainability activities have limited potential to contribute to reputation and brand due to mainly internal focus	Sustainability activities contribute to reputation and brand as they are boundary-spanning and integrating stakeholders
Innovative capabilities	Innovations to obscure non-performance with regard to sustainability (e.g. “greenwashed” products)	Process, product, and organizational innovations limited by boundaries of existing business logic	Sustainability-oriented process, product, and organizational innovations transform business logic; sustainability problems and stakeholders are considered a key source of innovation

A number of barriers exist that inhibit companies from realising the business case for sustainability, typically due to distorted accounting and management information systems (Wallmann, 1995). The initiatives that might address such issues are often varied, complex, beyond the realms of knowledge of many business managers, and may represent significant changes at an operational level (Hofferman and Bazerman, 2005). They require clear understanding of the potential benefits available and underlying concepts at senior management level, as well as strategic leadership that may drive changes in the organisation (Hofferman and Bazerman, 2005). The result is that the business case for sustainability does not automatically become apparent to businesses, and thus act as a driver for change; rather, such cases must be created through sustainability management that is both able to understand the need for change (i.e. first principles thinking), the options available for change, and thus the develop a desire to change. Foresight is the key to survival. Managers who can spot trends and capitalise upon them are able to take advantage of the changing market and to reposition their businesses before new entrants to the market become a serious threat, or potential physical or legislative risks to their business become realised (Hart and Milstein, 1999).

It has been contended that today's large firms have the ability to go beyond the neo-classical model of the firm. Furthermore, they have the required organisational abilities to both understand the role they play in society, and have the resources to take responsibility for their actions (Tomer, 1999). Once the firm becomes aware of the role it plays in society it becomes inherently influenced by a variety of external factors, with the ability of a firm to recognise and take action on these influences being determined by its internal organisational capabilities. Tomer (1999) termed this the 'socio-economic' model of the firm (see Figure 2-4). As in the neo-classical model of the firm, companies remain profit-maximising , but do so in accordance with moral values, commitments to the community, and other social bonds (Tomer, 1999), recognising that they cannot survive without addressing such externalities. It thus becomes in their best interest to preserve and strengthen these bonds (Metcalf and Benn, 2012).

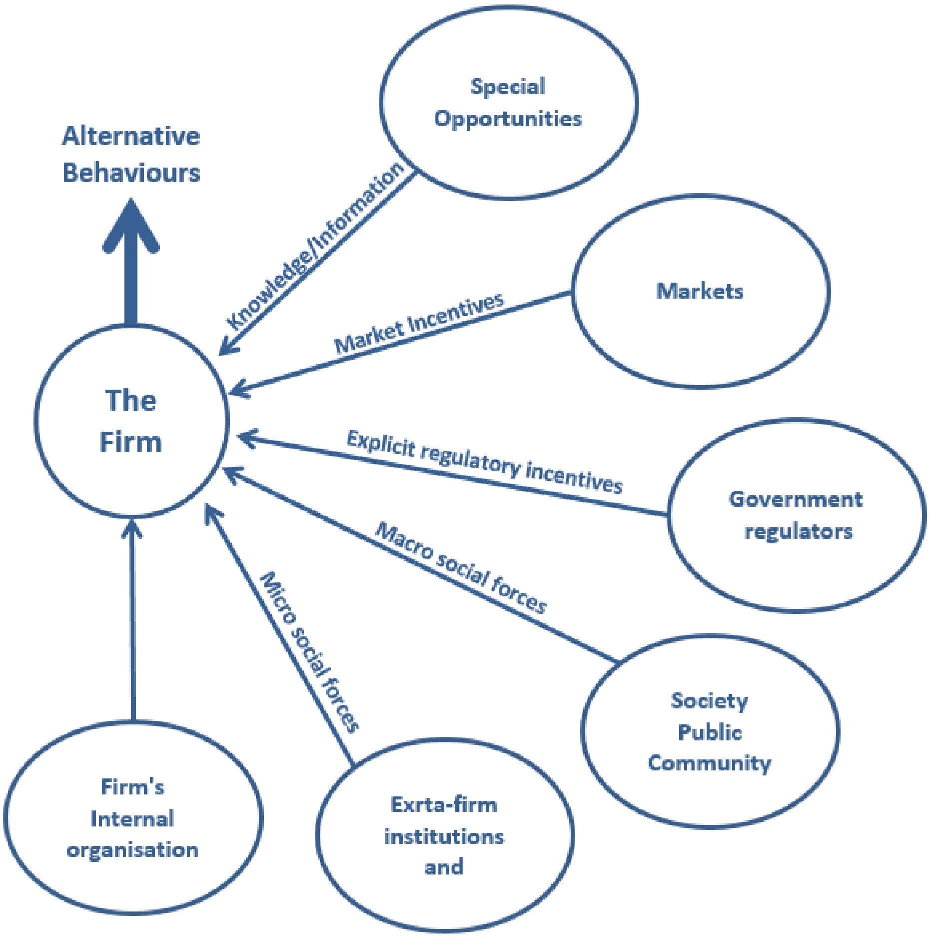


Figure 2-4; the Socio-Economic' Human' model of the firm (After Tomer, 1999)

It is the ability of the firm to be aware of its external environment, and to act in its best interests, that can enable it to operate in a way that can be viewed as sustainable (and for those organisations that are looking to change their operations in such a way there is much potential). Greater awareness of a company's socio-economic influences enable the business to be unconstrained by their social relationships, and to be more effective because of them, enabling competitive advantage (Tomer, 1999). In doing so firms reduce the need for state intervention and increased regulation that are a requirement of the neo-classical model to ensure that wider societal needs are being met (Coles *et al.*, 2013). The literature also points to other theories that support the case for firms to act this way (Moir, 2001):

- **Legitimacy Theory;** if society perceives a firm to have broken its 'social contract' with them, by acting in what it deems to be an illegitimate manner, then society will effectively revoke the organisations 'contract' to continue its operations (Davies, 1997). This may see them boycott such products in favour of competitors. In this way, pro-social endeavours are a corporate response to external pressures to ensure a perception of legitimacy.

- **Stakeholder Theory;** this can be seen as an attempt by firms to create a perception that they have more than one primary interest in their operations, beyond that of their shareholders. In this way, firms will pay attention to the requirements of all individuals, groups or other externalities that have a vested interest in the activities of the firm. In doing so the wants and needs of these groups will figure prominently in the decision-making process of the firm (Moir, 2001).
- **Instrumental Theory**; states that pro-social actions by a firm may improve company image, public relations and competitive advantage, in a way that does not jeopardise the firm's ability to generate profit. Further, such behaviour can increase a firms 'reputational capital', inasmuch that market forces can provide financial incentives for firms that are able to elicit a perception of being socially responsible (Moir, 2001)

It is through the concepts discussed in this section that that the win-win case of sustainable development for businesses can be seen; indeed, this is the most common way in which sustainability is marketed towards businesses to date (see for example; Porter & van der Linder, 1995; Natrass and Altomare, 1999; Hawkden, 2010; Lovins and Cohen, 2011; Anderson, 2009). Porter and Kramer (2006, 2011) discuss this concept in terms of creating 'shared value', that is; a focus on the connections between the triple bottom line[19] of the firm for a more holistic benefit of the firm's economic goals, and its societal responsibilities. They claim that such an approach can deliver social benefits and increased economic performance for firms who embrace sustainability, over those that do not. Such benefits are rooted in the idea that successful firms require a healthy society, in which education, healthcare and equal opportunities are essential for a productive workforce, as well as efficient utilisation of natural resources to facilitate increased productivity (Porter and Kramer, 2006). This encapsulation of the win-win situation between a firm and its stakeholders recognises that societal harms frequently create internal costs, be it through wasted energy, waste disposal costs, costly accidents or employee training at times when state education may have left skills

[19] Constituting social, environmental and financial issues (see Elkington, 1994).

gaps (Porter and Kramer, 2011). Such theories go against those espoused by the likes of Friedman introduced in Section 2.3, by acknowledging that as integral parts of society, businesses have roles and responsibilities to it - and indeed may profit from such considerations (see Luthans *et al.*, 1987; Tomer, 1999).

Natrass and Altomare (1999) identify a number of other drivers for action on sustainability, illustrated through their 'Resource Funnel' (see Figure 2-5). As demand for resources increases concurrently with growing global prosperity and population, the availability of resources becomes scarcer, placing any businesses that rely upon them under pressure, for example:

- Competition, costs, raw material shortage, natural disasters, and environmental remediation;
- Pressure from more environmentally concerned citizens, boycotts and bad publicity;
- Regulations (i.e. environmental, health and safety), standards (i.e. CSR activities and ISO ratings), and fees (i.e. waste / carbon), and
- Competition for the best employees, employee loyalty, health and need for meaningful work.

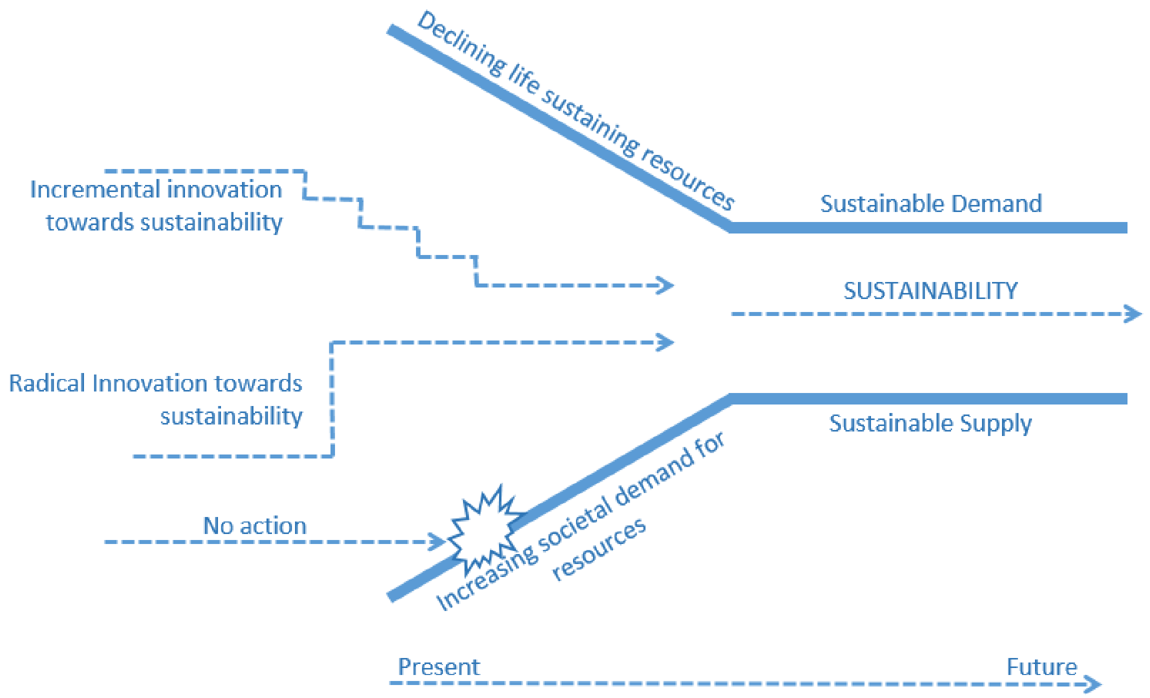


Figure 2-5; The Natural Step Resource Funnel (Adapted from Natrass and Altomare, 1999). Through this figure it can be seen how, as natural resource supply decreases, an demand rises, the margin for action by businesses to operate in such conditions (i.e. sustainably) decreases. Businesses have the option of incremental step changes towards sustainability, radical leaps towards sustainability, or taking no action and not being fit for purpose in such a society.

As the walls of the resource funnel close, the margin for action by businesses narrows and the number of appropriate business models that may see them operate successfully falls. It is therefore in their best interests to act early, rather than take a protectionist stance that looks to preserve the incumbent economic system. As businesses move towards sustainable business models and natural resource use falls, the funnel may cease closing and, with restorative economies such as those advocated by Hawken *et al.* (1999), the funnel may even begin to open again.

Natrass and Altomare (1999) recommend incremental step changes towards sustainability, proposing four key processes that must occur for a business to do so:

1. To perceive the nature of unsustainable direction of business and society, and the self-interest implicit in shifting towards sustainability;
2. To understand the first-order principles of sustainability, i.e. the four system conditions previously introduced.
3. To apply strategic visioning by ‘back-casting’ from a future sustainable vision to present position, with steps identified along the way; and
4. Identifying strategic steps to move the company from its current reality, towards its desired vision, by focusing first on the ‘low hanging fruit’.

Honkasalo *et al.* (2005), take a similar approach, identifying six processes that may facilitate eco-efficiency in firms (see Figure 2-6). They also recognise that signalling of a need for change is a key driver, together with an understanding of the opportunities that await businesses who do act. Taking incremental steps towards sustainability helps to embed sustainability thinking within a firm, making management aware of the wider issues surrounding Sustainable Development, to witness win-win benefits first hand, and to begin to build a Sustainable Development competencies. Additionally they add the need for learning opportunities within the firm, and flexibility in developing solutions as per theories surrounding the Learning Organisation[20].

[20] A company that facilitates the learning of its employees and continuously transforms itself according to changing externalities that it is overtly aware of, in order to remain competitive (see Easterby-Smith, Burgoyne, Araujo, 1999).

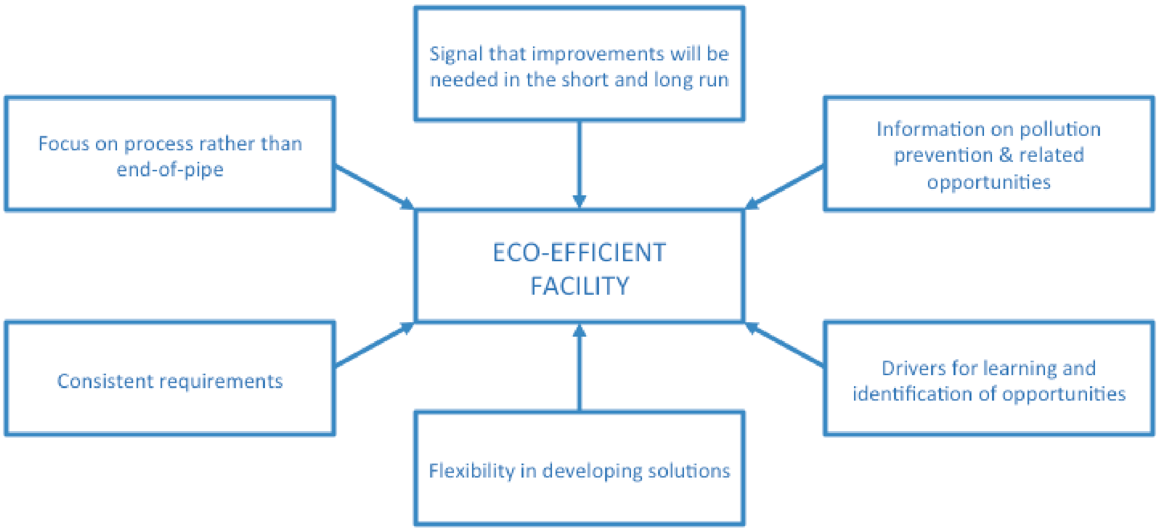
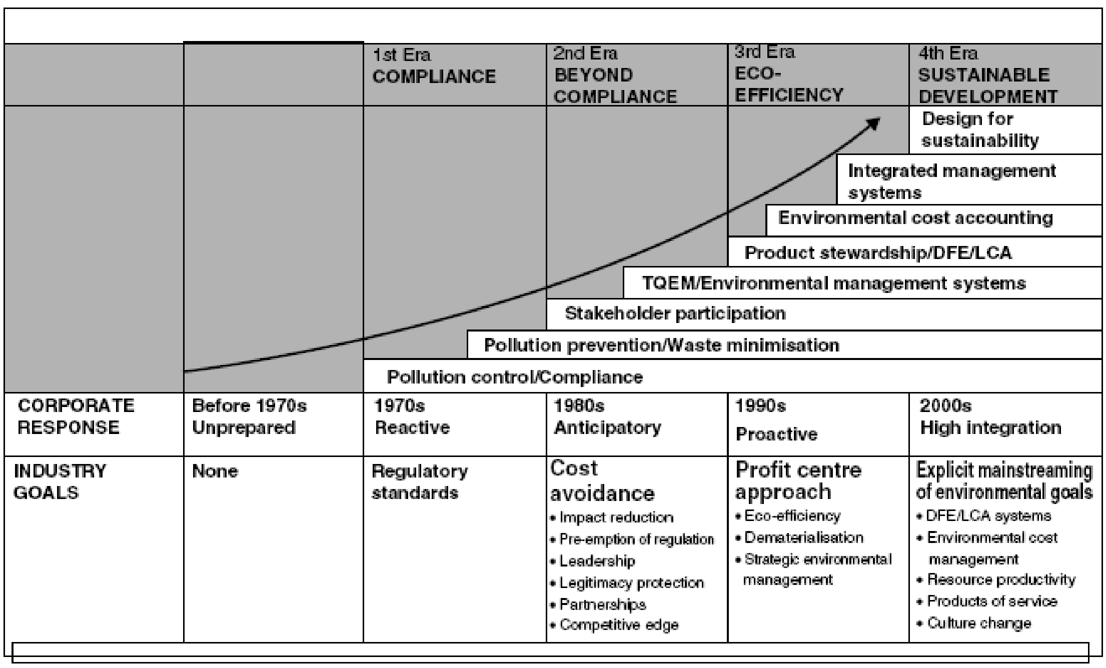


Figure 2-6; Processes that may facilitate eco-efficiencies in firms (Honkasalo *et al.,* 2005)

Of particular note here is the fact that the authors advocate choosing the 'low-hanging fruit' solutions to sustainability first; clear advocacy of a more incremental step towards sustainability. By moving incrementally in this way (following the theory of First Order Principles[21]), the business world has already seen a change in the way it views issues of sustainability, as illustrated in Figure 2-7 below. For businesses that are new to sustainability thinking however, the learning curve is steep and moving from an unprepared state to a highly integrated state can be difficult.



[21] That is, the core principles that underpin a given issue. As such, they represent the logical starting point with which to tackle an issue (Natrass and Altomare, 1999).

Figure 2-7; The Sustainability Learning Curve (Natrass and Altomare, 1999)

As far reaching as the approach advocated by the Natural Step Framework is, Wells (2013) argues that it is an inherently incremental and conservative approach that may deliver yield performance over time, but does not have the capacity to "challenge the essence of the business models that underpin much unsustainable activity" (ibid, 76). Similarly, Dyllick and Hockerts (2002) state that concepts such as eco-efficiencies may deliver environmental gains, but that they do little to tackle the underlying problems of over-consumption; rather they provide advocacy for the incumbent system by not challenging it's fundamental principles, by providing those who engage in such activities with an enhanced licence to operate. Eco-efficiencies can also be argued against in that they can be overshadowed by sector growth. An example of this, as discussed in Section 2.9, is the aviation industry. This sector has for many decades delivered significant annual efficiency improvements in terms of CO_2 emissions per kilometre flown. Such efficiencies have however failed to keep pace with sector growth – resulting in total emissions for the sector increasing.

There is a large and growing body of examples where businesses have been able to enhance their sustainability performance by implementing these types of efficiencies (for multiple examples see Weiszacker 1997, and Hawken *et al.*, 2005). Indeed, Hawken *et al.* (1999), state that resource efficiencies are one of the ways in which businesses may help to deliver on Sustainable Development objectives, by moving incrementally towards a paradigm shift in business activity, citing the following as requirements for Sustainable Development to be delivered:

- improved efficiency from natural resource use;
- reduction of waste via closed-loop systems[22];
- investment in natural capital[23] so that businesses are able to maintain, restore and expand the planet's eco-systems, and;
- the development of solutions based business models in which value is delivered from the sale of services, rather than goods, i.e. to provide 'illumination', rather than selling light bulbs. This represents a new

[22] In which waste and materials from a products use, manufacture and disposal is kept within the productivity system to deliver further value, rather than simply becoming 'waste'.
[23] Defined as the world's stocks of natural assets which include geology, soil, air, water and all living things (Natural Capital Forum, 2014)

perception of value, moving away from product, to solutions; this is an area addressed further in to Section 2.7.

The discourse between whether society would be best served by incremental improvements in the current imperfect system, or by a complete, costly, and risk-laden redesign of entire industries and societal and economic systems remains a matter of debate. This is particularly challenging when consumers desire the products and services offered by a sector, and where wealth creators make it difficult for regulations to force change. For this reason, it is necessary to consider the role of businesses in delivering Sustainable Development, and how businesses may incorporate such thinking into their businesses.

2.5 The need for sustainable business models

"Sustainable solutions to sustainable development problems will […] require sustainability-oriented business models"

Charter and Clark, 2007:18

As the call for businesses to internalise previously externalised issues increases, non-compliant businesses will have to change in order to achieve legal compliance, to gain social legitimacy of their operations, and to seek out competitive advantage. (Birkin *et al.,* 2009). This section details the characteristics of businesses who must change to in order to adapt to sustainability issues, before introducing business model theory at the organisational level, and introducing Osterwalder and Pigneurs (2010) Business Model Canvas – a framework for understanding the business model of a given organisation that is used in this research project.

2.5.1 Conceptualising the sustainable business model

A sustainable business model can be viewed as forming the conceptual link between the components of Sustainable Development – as outlined in Section 2.3 - and the fact that a firm needs to stay profitable in order to exist (Boons *et al.,* 2013). This is important because at a fundamental level an uncompetitive business model is not a sustainable one (Wells, 2013) as it will eventually cease to exist, provide employment, contribute to the economy, and provide goods and services that enhance the quality of life of its users. This has particular relevance for those sectors that play a more significant role in the socio-economy, for example the aviation sector, as discussed in Section 2.8.

Whilst there has been much research carried out into the changes required at a societal level to promote sustainable development, there has been relatively little academic research into understanding sustainable business models, and how sustainable development principles may be operationalised in firms (Stubbs and Cocklin, 2008). This has led to the concept of the ‘business model’ being largely used in an ambiguous way in the sustainable entrepreneurship and corporate sustainability management literature (Boons and Lüdeke-Freund, 2013). This situation is however changing, as academic attention on sustainable development and the role of business in facilitating this concept increases.

The idea of sustainable business models arose in the 1990s when Hawkden *et al.* (1999) related the concept to that of 'natural capitalism', and the creative destruction[24] of existing industries because of sustainability challenges (Boons *et al.,* 2013). This has seen the field rooted in wider normative concepts such as environmental sustainability (Boons and Lüdeke-Freund, 2013), and industrial ecology (Wells, 2013), such as energy efficiency improvements that deliver savings at the bottom line. These concepts follow the Sustainable Development requirements outlined by the likes of Hawken (2009), Weiszacker (1999), and Natrass and Altomare (1999) in their ability to deliver lower environmental impact, and greater economic output.

For firms looking to integrate sustainability concepts at a more fundamental level, embedding the concept at a high organisational level appears key. Nidumolu, Prahalad, & Rangaswami (2009) for example, claim that only companies that make sustainability an embedded goal, in which business models are rethought (as well as their intrinsic products, technologies and processes), will be able to achieve the competitive advantage from sustainability.

[24] The continual product and process innovation mechanism by which new production units replace outdated ones – a central component of capitalism (Schumpeter, 1973)

According to Stubbs and Cocklin (2008) a sustainable business model is one in which “sustainability concepts shape the driving force of the firm and its decision making” (ibid, 103). That is, they do not just describe specific sustainability initiatives; they describe the processes by which an organisation looks to create value for its customers, through products, activities and networks geared towards embedded sustainability principles. In doing so, businesses must “develop internal structural and cultural capabilities to achieve firm-level sustainability and collaborate with key stakeholders to achieve sustainability for the system that an organisation is part of” (ibid, 103). Boons and Lüdeke-Freund (2013) state that this can be achieved by shifting business financial models from a “price-per-unit” to price per “job-to-be-done” focus. That is, a focus on the fulfilment of needs rather than the production, sale, and consumption of goods; an approach very similar to the idea of the Product-Service System – introduced in Section 2.7. This sentiment is supported by the US Environmental Protection Agency who state that the potential of a business model, from a sustainability perspective, is a function of three factors:

- Macro-level environmental performance; that is, eco-efficiency gains over ‘business-as-usual’ operations.
- Market Potential; i.e. the potential of a sustainable business model to become the ‘business-as-usual’ means to obtain a particular economic function or service.
- Environmental significance; the portion of national emissions, pollutant loads of resource demands that can be attributed to the manufacture, use, delivery and end of life management of the principle goods or services compared to the ‘business-as-usual’ alternative.

This is further echoed by UK-based Forum for the Future (Forum for the Future, 2011), who state that such models must be:

- Commercially successful; why is the proposition valuable to the customer and how can the business gain profit from it?
- Future ready; for example, the model must be able to succeed in a world of rising, volatile energy and commodity prices.
- Part of a sustainable society; that is, all business model components conform to the principles of sustainability, for example by internalising

externalities, or decoupling economic performance from environmental harms.

Clearly there is a need for businesses to develop business models that are both economically profitable, but that also follow the fundamental principles of sustainability. For businesses developed under the neo-classical economic paradigm, achieving such aspirations represents a considerable change, requiring a holistic re-approach to their business to operate in ways that can positively contribute to externalities that may have little or no direct contribution to short-term profitability (Tomer, 1999).

2.5.2 Sustainable business model archetypes and elements

Drawing on the definitions of sustainable development and the underpinning issues discussed in Section 2.3, sustainable business models provide the link between sustainable innovation and economic performance at higher system levels (Boons *et al*., 2013). This sees the business model act as a framework to understand how and what a business does, and provides a structured way for sustainable business thinking to take place, doing so by mapping purpose, opportunities for value creation across the network, and value capture in that business (Bocken *et al.*, 2015).

Hart and Milstein (1999) discuss three different types of economy in the world, each requiring its own type of sustainable innovation:

- The consumer economies of the industrialised nations require new models that reduce corporate footprints, and decouple production and consumption from social and ecological impacts.
- Survival economies (the rural lifestyles of the developing nations) require different business models than western consumption based models, based around local environmental, cultural and economic conditions.
- The emerging economies require models that find new ways of meeting the needs of people who have their basic needs met, but who aspire to have the same purchasing power and access to goods as those in developed nations.

Such varied requirements mean that no one sustainable business model will be appropriate for all the world's organisations. The range of challenges faced, and the industries affected mean that there is no ubiquitous conceptual notion of what a sustainable business model looks like (Boons and Lüdeke-Freund, 2013).

Boons and Lüdeke-Freund (2013) propose classifying sustainable business models by whether they are social, technical, or organisational in nature. Whilst this may have use from a broad analytical perspective, in terms of practical use it could be argued that such definitions do little to deepen the knowledge of the field (Bocken *et al*., 2014). Further classifications are however sparse and "few authors have sought to unify the various examples in literature and practice in a useful categorisation under the over-arching theme of business model innovation" (Bocken *et al*., 2014:44). It is to this aim that Bocken *et al*. (2014) set out to categorise archetypes of sustainable business models, to bridge this literature gap. In doing so eight archetypes were identified, each rooted in the higher order groupings defined by broad archetype categories identified by Boons and Lüdeke-Freund (2013), being technological, social or organisational in nature. Each of these archetypes are presented in Table 2-3.

Table 2-3; Business Model Archetypes (Bocken *et al.* 2014)

Groupings	Archetype	Value Proposition	Value Capture
Technological	Maximise material and energy efficiency	Products or services that use fewer resources, generate less waste and emissions and create less pollution than products/ services that deliver similar functionality.	Costs are reduced through optimised use of materials and reducing waste, and compliance leading to pricing advantage. Positive contribution to society and environment through a minimised footprint.
	Create value from waste	The concept of 'waste' is eliminated by turning waste streams into useful and valuable input to other production.	Economic and environmental costs are reduced through reusing material, and turning waste into value. Positive contribution to society and environment through reduced footprint, waste and materials use.
	Substitute with renewables and natural processes	Reduce environmental impacts and increase business resilience by addressing resource constraints associated with non-renewable resources.	Revenue associated with new products and services. Value for the environment is captured through reducing use of non-renewable resources, reducing emissions associated with burning fossil fuels, reducing synthetic waste to land-fill
Social	Deliver functionality rather than ownership	Provide services that satisfy users' needs without having to own physical products. Business focus shifts from manufacturing 'stuff' to maximising consumer use of products, so reducing production throughput of materials.	Consumers pay for the use of the service, not for ownership of physical products. Cost of ownership of physical products are borne by the company and / or partners. This can enable consumers to access previously expensive products, so expanding the market potential of new innovations.
	Adopt a stewardship role	Manufacture and provision of products and services intended to genuinely and proactively engage with stakeholders to ensure their long-term health and well-being.	Stewardship strategies can generate brand value and potential for premium pricing. Stakeholder well-being and health generate long-term business benefits for the company: Healthy customers are good for the firm and for society, healthy happy workers may claim less sick days and may be more productive, and secure suppliers ensure more resilience.
	Encourage sufficiency	Product and service solutions that seek to reduce demand-side consumption and hence reduce production (e.g. durable, modular, education about reduced consumption).	Profitability (premium pricing), customer loyalty, and increased market share realised from provision of better products (longer lasting, durable / not subject to short fashion-cycles).
Organisational	Resource for society / environment	Prioritizing delivery of social and environmental benefits rather than economic profit (i.e. shareholder value) maximisation.	A meaningful enterprise, which delivers nutrition, health, and education and a low environmental cost, while being embedded in community and employment rich.
	Develop scale up solutions	Scaling sustainability solutions to maximise benefits for society and the environment	Ensuring a variable (e.g. franchising, licensing) or fixed (mergers and acquisitions) fee is paid for scaling up a solution/venture and that other mutual benefits between partners are achieved through scaling up.

Similar categorisation of sustainable business models was reported in SustainAbility (2014), a study that, based on a review of 87 organisations, identified twenty business model innovations, split across five broad categories, which can be considered sustainable, (See Table 2-4).

Table 2-4; Sustainable Development Innovations (SustainAbility, 2014)	
Category	Innovation
Environmental Impact	Closed-Loop Production: The material used to create a product is continually recycled through the production system.
	Physical to Virtual: Replacing brick and mortar infrastructure with virtual services.
	Produce on Demand: Producing a product only when consumer demand has been quantified and confirmed.
	Rematerialisation: Developing innovative ways to source materials from recovered waste, creating entirely new products.
Social Innovation	Buy One, Give One: Selling a specific good/service and using a portion of the profits to donate a similar good/service to those in need.
	Cooperative Ownership: Companies owned and managed by members, often taking broader stakeholder concerns into account, including those of employees, customers, suppliers, the local community and in some cases, the environment.
	Inclusive Sourcing: Retooling the supply chain to make a company more inclusive, focusing on supporting the farmer or producer providing the product, not just the volume of the product sourced.
Base of the Pyramid	Building a Marketplace: Companies build new markets for their products in innovative and socially responsible ways, including delivering social programs, adapting to local markets, and bundling with other services like microfinance and technical assistance.
	Differential Pricing: Realizing customers may benefit from the same product but have different payment thresholds, companies charge more to those who can afford it in order to subsidize those who cannot.
	Microfinance: Providing small loans—and in some cases access to financial services—to low-income borrowers who do not have access to a traditional bank account.
	Micro-Franchise: Leveraging the basic concepts of traditional franchising, but specifically focusing on creating opportunities for the poor to own and manage their own businesses.
Financing Innovation	Crowdfunding: Enabling an entrepreneur to tap the resources of his/her network to raise money in increments from a group of people.
	Freemium: Offering a proprietary product or service free of charge, but charging a premium for advanced features, functionality or virtual goods.
	Innovative Product Financing: Consumers lease or rent an item that they can't afford or don't want to buy outright.
	Pay for Success: Employing performance-based contracting, typically between providers of some form of social service and the government.
	Subscription Model: Customers pay a recurring fee, usually monthly or annually, to gain on going access to a product or service; model has been used to lower barriers to entry to the purchase of green innovations.
Diverse Impact	Alternative Marketplace: When a firm circumvents a traditional method of transaction or invents a new type of transaction to unleash untapped value.
	Behaviour Change: Using a business model to stimulate behaviour change to reduce consumption, change purchasing patterns or modify daily habits
	Product as a Service: Consumers pay for the service a product provides without the responsibility of repairing, replacing or disposing of it.
	Shared Resource: Enabling customers to access a product, rather than own it, and use it only as needed; often dependent on the participation and generosity of community members to share their goods with others.

Implementing the archetypes found above may have significant opportunities for firms; from minimising risks, to delivering resource efficiencies, and creating and gaining competitive advantage in new markets. Wells (2013) however, states that implementing such models may face difficulty in terms of customer expectations. Consumers expect that new technologies and products will do more, but cost less; or will provide new features for which they are willing to pay a premium. ‘Green’ products however struggle on this premise as they are often more expensive than the competition (as a result of the internalisation of externalities) and so the additional benefits they are deliver are likely to only appeal to those who are environmentally aware (Wells, 2013). Business models help to bridge this gap by identifying mechanisms that may capture wider benefits for consumers, or to find new ways to define the additional costs incurred. For example, the relatively popular uptake of low energy light bulbs has been largely sold to the public on the grounds of reduced energy costs, rather than on environmental savings.

2.6 Understanding business models

Business model innovation, such as those described above is common across all corporate sectors, innovation being a key component of a firm’s ability to respond to changing market conditions, and the search for increased competitive advantage. A number examples are evident of businesses innovating their business model to obtain increased growth, such as those examples listed in Table 2-5 below.

Table 2-5; Examples of Radical innovations in firms

Company	Current Business	Initially
Nintendo	Computer games and consoles manufacturer.	Founded in 1889, Nintendo made first computer console in 1974. The firm started life as a playing cards manufacturer. (Nintendo, 2015)
Tiffany & Co.	One of the world’s leading luxury jewellers	Began life in 1837 as a "stationery and fancy goods emporium” (Tiffany & Co., 2015)
Apple	Technology Company	Founded in 1974 as a home computing company. Today the company is the largest seller of mobile phones and has expanded into digital media (Apple, 2015).
Nokia	Telecommunications manufacturer	Initially founded in 1865 as a paper manufacturer, before evolving into Finnish Rubber Works in 1898. (Nokia, 2015)

Such innovation is particularly important where, as is often the case for sustainable development, there is an absence of technological solutions. Indeed, technological innovations themselves are heavily reliant on business models in order to be successful themselves, with Chesbrough (2010) stating that “A mediocre technology pursued within a great business model may be more valuable that a great technology exploited via a mediocre business model" (ibid:P355).

The next section reviews the mainstream ideas of business models in more detail, followed by a detailed explanation of Osterwalder and Pigneurs (2010) Business Model Canvas – a framework for understanding given business models for a given business – used in this research project.

2.6.1 The shifting meaning of a business model

Due to an increasing association with competitive advantage (Johnson *et al.,* 2008), the application of business model theory in practice has grown in recent years, with Wirtz *et al.* (2015) describing how an 2007 IBM survey of 765 managing directors found that over-performing firms focus on business models at a higher rate than under-performing firms. Despite this, the understanding of business models is somewhat heterogeneous in the literature (Wirtz, 2015).

The term 'business model' has its roots in the fields of information technology, through which practitioners and academic theorists saw the concept as referring to technological innovation with a focus on organisational processes (Wirtz *et al.*, 2015; Chesbrough, 2006). As the term gained more popularity, the literature began to focus on organisational theory, accompanied by enhanced definitions, which break the business model concept down into specific elements or components, through which one may analyse the competitive structure of a firm, and the strategic decisions it makes (for example Osterwalder and Pigneur, 2010). Figure 2-8 illustrates the development of business model theory, detailing key papers that have contributed to its modern understanding (Wirtz, *et al.*, 2015).

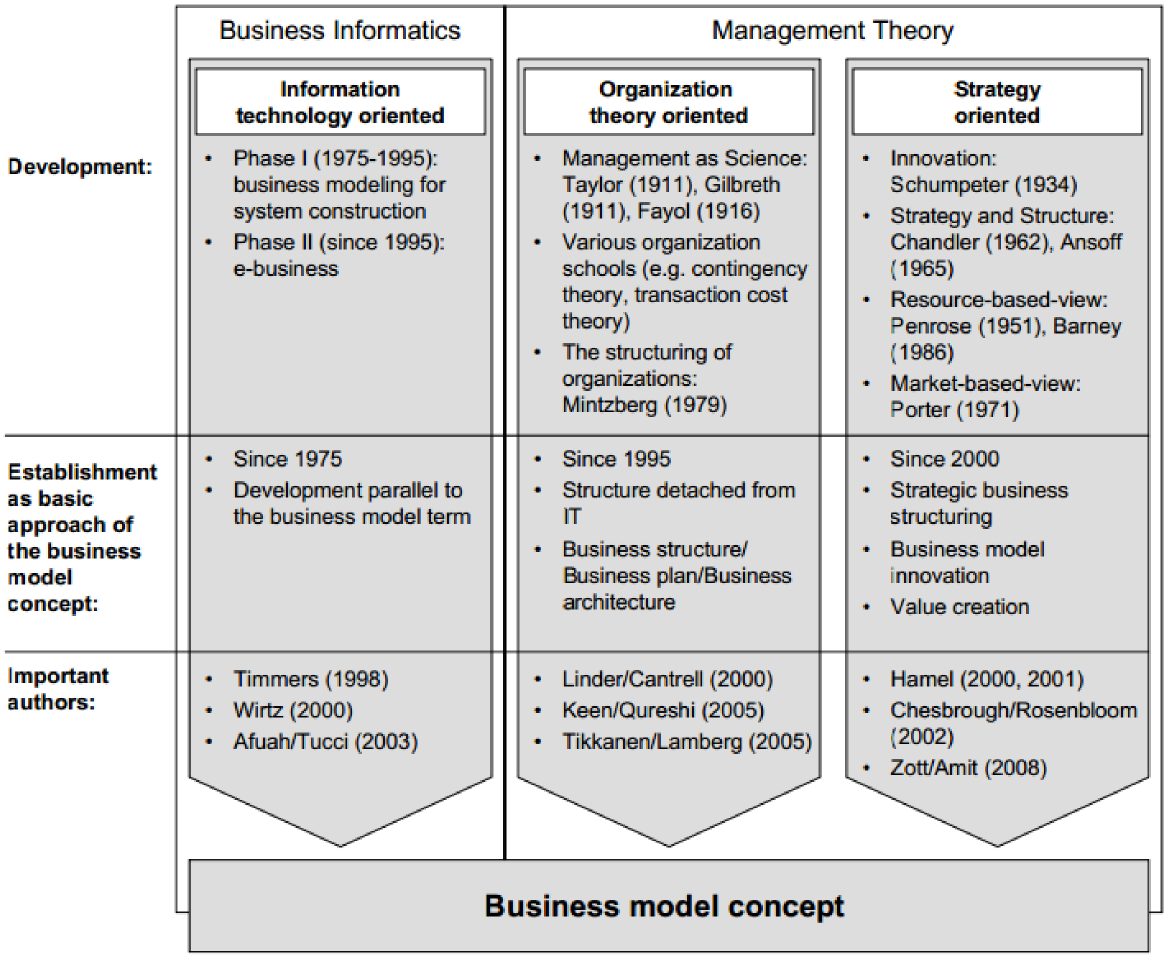


Figure 2-8; Basic theoretical approaches for the business model concept (Wiritz *et al.*, 2015)

Modern attempts at business model definition seem to encapsulate similar fundamental characteristics. Indeed, following a literature review of the definitions, Bocken *et al*. (2015) categorised the business model as comprising three primary components:

- Value Proposition; What value is provided and to whom? Including the product/service, customer segments and relationships, the value for the customer, society and environment.
- Value creation and delivery; How is value provided? Including, activities, resources, distribution channels, partners and suppliers, technology and product features.
- Value Capture; How does the company make money and capture other forms of value? Including cost structure and revenue streams, value capture for key actors (including the environment and society), and the growth strategy ethos of the company.

Wells (2013) discusses the business model in some detail, describing it as going beyond technological innovation, towards a means of understanding the organisation of a business in a holistic manner, or "the way a company is structured to do business" (ibid: 22). He goes on to explain that "Business Models are a useful means of simplifying the complexity of business in order to make it understandable, even at the cost of accuracy […] They are an abstraction; but also a tool for discourse as much as an empirical methodology; they are a way of thinking about the world and helping us categorise businesses to see their similarities and differences" (ibid: 22).

Similarly, Amit and Zott (2010) state that business models describe "the content, structure, and governance of transactions designed so as to create value through the exploitation of business opportunities", being an "important locus of innovation and a crucial source of value creation for the firm and its suppliers, partners, and customers" (Amit and Zott, 2010:p221). They expand on this definition some years later stating that the business model is "a system of activities that depict the way a company 'does business' with its customers, partners and vendors" describing "the bundle of specific activities that are conducted to satisfy the perceived needs of the market, including the specification of the parties that conduct these activities, and how these activities are linked to each other" (ibid:p2).

Such classifications are similar to that of Teece (2010:172) who defines the business model as "the architecture that the company has chosen for its value creation and appropriation mechanisms", that is, the business model must specify:

- ***What*** is the value being created?
- ***Who*** is this value being created for?
- ***How much*** value is being created?
- ***How*** is the value being created?

In this regard, we can see that a fitting definition of the business model is provided by Osterwalder and Pigneur (2010) who describe the business as "the rationale of how a firm creates, delivers and captures value". Additionally they describe "how customers are encouraged to pay for the value created by a firm through the services it provides or the products it delivers, and how this money is converted into profit" (ibid;14).

Business models lie in the middle of a continuum between specific business processes and business strategy. Sorescu (2011) defines the difference between business models and business strategy as "strategy articulates a certain goal, whilst the business model details the mechanisms that move the organisation towards that goal" (ibid:4). That is, strategy specifies how a firm aims to differentiate from its rivals to gain competitive advantage (Margretta, 2002), whilst business models focus on the organising logic of how to create and appropriate value, in a way that achieves the competitive advantage desired (Sorescu, 2011). Conceptually, argues Sorescu (2011), this may result in a firm having an overarching strategy to guide their organisation, with a number of business models operating within that strategic framework, tailored towards different products, as illustrated in Figure 2-9.

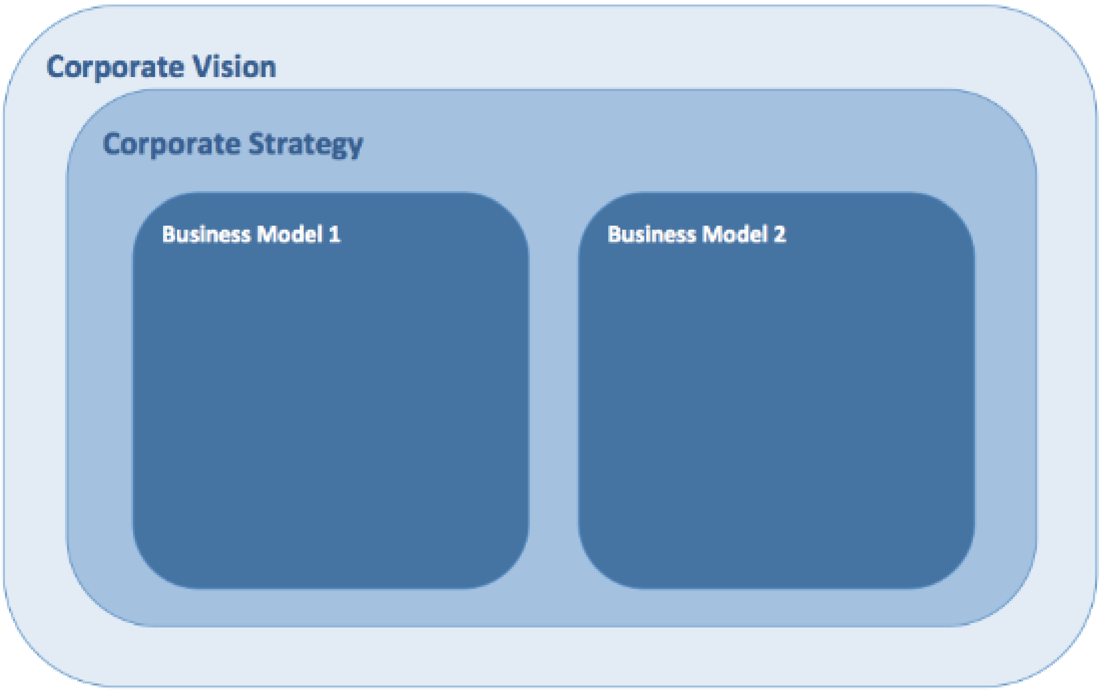


Figure 2-9; illustrating how corporate strategy may inform on a number of different business models within the same firm (authors own).

Adopting a new business strategy implies the creation of a new business model to achieve that strategy, however the business model may be changed to increase competitive advantage, but within the same strategic direction (Sorescu, 2011). Thus, changes to strategy can be seen as requiring wholesale change across an organisation, whilst changes to a business model may provide a way to increase the profitability, sustainability, or other business objective, whilst maintaining a firms central goals and vision.

2.6.2 Types of business model

In terms of the types of business model that exist, Weill *et al*. (2005) identified four business model archetypes. Each of these (creator, distributor, landlord and broker) comprise a number of sub-archetypes depending on the types of asset involved in each, as illustrated in Figure 2-10 below.

		What Type of Asset is involved?			
		Financial	Physical	Intangible	Human
What Rights are Being Sold?	Creator	Entrepreneur	Manufacturer	Inventor	Human Creator
	Distributor	Financial Trader	Wholesaler / Retailer	IP Trader	Human Distributor
	Landlord	Financial Landlord	Physical Landlord	Intellectual Landlord	Contractor
	Broker	Financial Broker	Physical Broker	IP Broker	HR Broker

Figure 2-10; business model archetypes (Weill *et al*., 2005)

Linder and Cantrell (2000) also attempted to categorise business models (see Table 2-6) doing so by focusing on the model's central profit-making activity, and its relative position on a price/value continuum – from high value to low cost items.

Table 2-6; Linder and Cantrell's (2000) categorization of business models

Business Model Category	Business Models
Price Models	Buying Club, one-stop, low-price shopping, fee for advertising, e.g. razor and blade.
Convenience Models	One-stop, convenient shopping, comprehensive offering, instant gratification
Commodity-plus models	Low-price reliable commodity, mass customised commodity, service-wrapped commodity
Experience Models	Experience selling, cool brands
Channels Models	Channel maximisation, quality selling, value-added reseller
Intermediary Models	Market aggregation, open market-making, multi-party market aggregation
Trust Models	Trusted operations, trusted product leadership, trusted service leadership
Innovation Models	Incomparable products, incomparable services, breakthrough markets

Beyond these broad set of archetypes, similar taxonomies in the literature appear to be limited to specific industries, typically in the Information Services sector. For example; Janssen *et al.* (2008), Hartman (2014), and Rappa (2001).

2.6.2.1 *Retail business models*

Whilst retailers could traditionally be classified as 'merchant intermediaries', who buy from suppliers and sell to customers, this is no longer the case (Sorescu *et al*., 2011). Retailers must now be considered as 'orchestrators of two-sided platforms that serve as ecosystems in which value is created and delivered to customers, and subsequently appropriated by the retailer and its business partners' (ibid;5).

Modern retail business models can be defined by two unique characteristics (*Sorescu et al.*, 2011):

1. *Retailers primarily sell products manufactured by others* and, as a result rarely derive benefits from exclusivity. Therefore, a narrow focus on product assortment is unlikely to provide long-lasting competitive advantage. Thus a successful retail business model focuses not only on what retailers sell, but how retailers sell.
2. *Retailers engage in direct interactions with end customers,* unlike manufacturers. Thus, the customer interface is vitally important, and successful business models articulate how the retailer will optimise the interactions it has with them and customer experience is key.

Further, they are defined by a set of three core elements (Sorescu, 2011):

- Retailing format; referring to the structures for sequencing and organising the selected retailing activities into coherent processes that fulfil the customer experience. For example, product assortment, pricing strategy, location, customer interface and so forth. In any product category, multiple formats are usually feasible, for example alcohol can be sold in supermarkets, on-line, licenced grocers, restaurants, and duty-free retailers, all of which differ in their assortment, pricing, location, interface and convenience offered.
- Retailing activities; referring to acquiring, stocking, displaying, and exchanging goods and services that fulfil the customer experience.
- Retailing governance; referring to the actors involved in creating and delivering customer experiences, and the mechanisms that motivate an intention to buy. This can include the retailer, its customers, and partners throughout the supply chain

The cohesiveness of these three elements plays a large role in the success of the retailer in question. If changing market conditions require a modification to this business model, Soresco *et al.* (2011) state that the company should first look to examine the linkages with format and activities, followed by appropriate updates to the three elements and their connections, done in a manner that optimises the value created and appropriated under the given constrains.

2.6.3 Business model components

The business model is more than a broad statement of how a business will go about meeting organisational objectives. Rather, a business model sets out the specific activities and relationships that exist within a firm that make a given business strategy possible. A number of attempts at categorising business elements have been made, perhaps the most popular being those identified by Osterwalder and Pigneur (2010) through their Business Model Canvas (BMC), developed from PhD research conducted by Osterwalder (2004) to develop a 'Business Model Ontology'. This tool has become widely used both in practice (see for example Henriksen *et al*., 2012; Kaplan, 2012) and increasingly common in the academic fields, (Kalakou and Macário, 2013; Bocken *et al*., 2013), and shares many similarities with the other classification attempts, for example Chesbrough (2006a; 2006b). The canvas visualises the business model as consisting of nine key elements that describe the rationale of how a firm creates, delivers and captures value, as illustrated in Figure 2-11 and expanded upon below: *et al.*

- **Value Proposition;** what is the firm's product / service value proposition to the customer? What does it do differently?
- **Customer Relationships;** what sort of a relationship does a firm have with its customers?
- **Channels;** what are the mechanisms the firm uses to distribute value? These could be physical or virtual.
- **Customer Segments;** what types of customer does the firm target? Are they a niche / mass market?
- **Revenue Streams;** how does the firm generate revenue from the customer? How does it get paid for its value?
- **Key Activities;** what activities are important to create value for the customer? What does the firm 'do'?

- **Key Resources;** what resources do the firm use to create value for customers? What are the company's assets?
- **Key Partners;** who does the firm work with to deliver value? What sort of relationships does it engage in?
- **Cost Structure;** what are the firm's costs in delivering upon its value proposition for the customer?

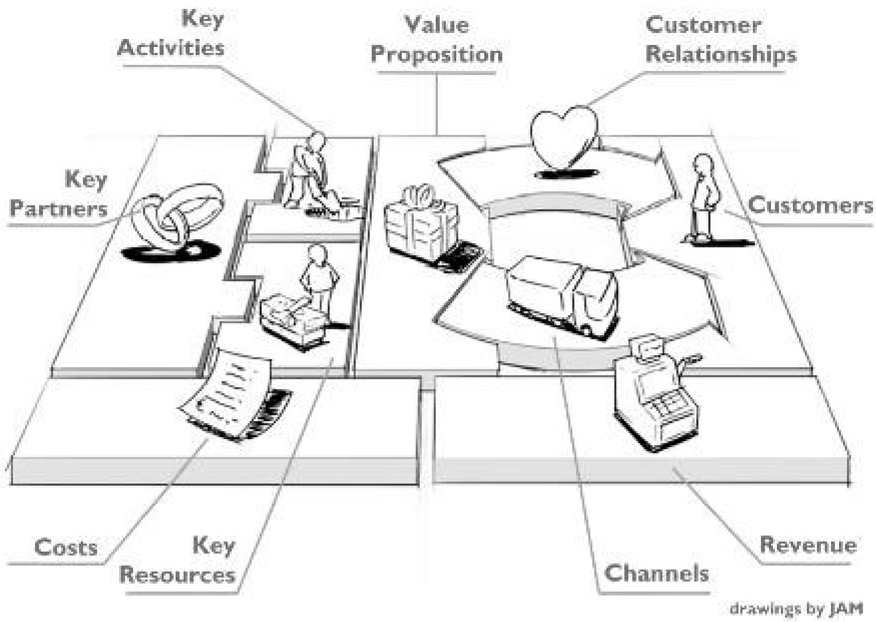


Figure 2-11; Osterwalder and Pigneur's (2010) Business Model Canvas.

Conceptually, the canvas illustrated in Figure 2-11 above comprises two sides. The left illustrates how value is created for the customer, with the result that the elements on this side of the canvas generally create costs for the firm. The right hand side of the canvas is associated with the delivery of this value to each given customer, and can be seen as the 'revenue' side of the canvas. For a business model to be successful, the costs on the left side of the model must be less than the revenues the canvas creates through the activities on the right hand side of the canvas.

In a comprehensive review, Wirtz *et al.* (2015) detailed the range of business model components referred to in the literature – see Figure 2-12. Here it can be seen how Osterwalder and Pigneur's (2010) work covers all but the procurement model component; albeit one may imply that procurement may represent a 'key activity' in the BMC, with suppliers involved in such procurement being represented in the ‘Key Partners’ element of the canvas. The fact that the BMC is relatively comprehensive compared to the work of other authors, combined with its common application in industry, suggests that the work of Osterwalder and Pigneur (2010) is appropriate framework for which researchers and practitioners alike are able to investigate incumbent business models of firms.

Author	Resources	Network	Customers	Market Offering (Value Proposition)	Revenues	Service Provision	Procurement	Finances	Number of Components
Hamel (2000)									2
Mahadevan (2000)									3
Wirtz (2000)									7
Hedman / Kalling (2002)									5
Bouwman (2003)									3
Afuah (2004)									4
Mahadevan (2004)									4
Voelpel / Leibold / Tekie (2004)									3
Yip (2004)									5
Lehman-Ortega / Schoetti									2
Osterwalder / Pigneur / Tucci (2005)									7
Tikkanen *et al.* (2005)									3
Al-Debei/El Haddadeh / Avison (2008)									3
Demial / Lecoq (2010)									4
Johnson (2010)									4
Osterwalder and Pigneur (2010)									7

Figure 2-12; Overview of selected business model components (Adapted from Wirtz *et al.* (2015)

2.6.3.1 Critique of the business model concept

Despite its increasing application in practice and academia, there are some criticisms of business model theory. As discussed above, there is a lack of a formal definition of what a business model is, and as argued by Zott *et al.* (2011), it remains an area that is somewhat theoretically underdeveloped with the argument made that it is unclear how a business model differs from other concepts such as value chains, value networks and activity systems. As a nascent and underdeveloped concept, this suggests that it is an area worthy of more research, particularly given its current levels of use.

A further critique of business model theory is that business models are inherently intangible entities. This can result in issues for some empiricists who have a preference for quantitative rather than qualitative research. Such critique may be addressed however by the fact qualitative research provides a number of methodologies and analytical tools that are able to uncover such intangible data in a robust and academically sound way, not least Case Studies method, as applied in this research. This is particularly true for organisational research where such methodologies are increasingly popular (McNiff, 2000). Furthermore, the BMC acts as a tool through which the intangible concept of a business model is made tangible, by illustrating it in a visual form based around a clear definition of what a business model is. This ensures that all participants in the creation or analysis of a business model created using the canvas have a shared definition to minimise any confusion.

2.6.4 Business model canvas

The previously mentioned Business Model Canvas (Osterwalder, 2004) is a popular tool in business model analysis and investigation – both in practice and in research. For example, Kalakou and Macário (2013) used the BMC to classify the different business models used by different types of airports (see Figure 2-13).

Key partners	Key activities	Value proposition	Customer relationships	Customer segments
• Airline alliances • Low cost airlines • Traditional airlines • Logistic companies • Cargo associations • Technology providers • Research institutions • Government • Regional authorities • Railway authority	• Environmental assurances • Real estate activities • Facilities refurbishment • Building branding • Live presentation of sport events • Provision of prayer rooms • Collaboration with railway • Airfield expansion	• Wide air connectivity • Multimodality • Fast passenger services • Plesant stay at the airport	• Online requests • Social networks • Regional events • Offices at the airport • Public meetings • Exhibitions • Blogs • Airport magazine	• All types of airlines
	Key resources		**Customer channels**	
	• Dedicated areas to airlines • Cargo+Business facilities • Kid facilities • Health facilities • Offices to rent in proximity • Technology for information sharing • Collaborative Decision Making (CDM) program		• Reports/publications • Media • Newsletter	
Cost structure		**Revenue**		
• Building refurbishment investments + new technology equipment • Architectural investments to save 30% of energy consuption and reduction of operational costs		• Concessions+Parking+Rentals • Real estate+Management of other airports • Local events organization (concerts) • Tours at the airport		

Figure 2-13; the business model of Frankfurt Airport (Kalakou and Macario, 2013)

The popularity of the BMC provides researchers with a means through which it is possible to draw effectively on the work on others, through a common definition of a given business model and the characteristics of its elements (Zott *et al.*, 2011). This is possible because the canvas itself acts as a definition of what a business model is, whilst its visual nature means that those participating in canvasing exercises are able to do so with a shared definition of the business model as a concept, but also of the specific business model under investigation (Osterwadler and Pigneur, 2010). This is particularly important considering the fact that the wider business model literature has “yet to develop a common and widely accepted language that would allow researchers who examine the business model construct through different lenses, to draw effectively on the work of others” (Zott *et al.*, 2011:1).

Additionally, the BMC enables research to move beyond the boundaries of a given business to include external activities and actors, such as customers, suppliers and competitors. It is in the detail of how these aspects link together that a business model can create cohesive and effective business models, as the linkage between these interdependencies has the ability to create more than the sum of its parts (Ennen and Richter, 2010). Understanding such connections is important as a well-designed business model is able to create ‘complementarities’ between the different elements, resulting in a more effective organisation than would be achievable by, for example, a product innovation on its own (Sorescu *et al.*, 2011).

Equally, a business model with weak synergies across the elements will deliver less value than might be otherwise expected.

As well as enabling an understanding an existing business model, one of the main functions of the BMC is its ability to inform how innovation may occur within such models, or how to design completely new models that may provide a firm with competitive advantage. Osterwadler and Pigneur (2010) identified five forms of innovation that typically come about from the canvases application:

- **Resource driven innovation**; referring to the process of transforming the business model including the company's infrastructure, key partners, and key resources.
- **Offer driven innovation**; offering customers a radical new value proposition affecting the other business model building blocks.
- **Customer driven innovation**; for instance innovation based on new customer needs, facilitated access or increased convenience.
- **Finance driven innovation;** that is, finding new revenue streams, pricing mechanisms or reduced cost structures.
- **Multiple-epicentre driven innovation**; characterized by several epicentres in the Business Model Canvas.

The ability of the canvas to drive innovation suggests that it may have potential application in addressing the issues of Sustainable Development, which, as we have already identified in Section 2.3, can require significant innovation from businesses in order to be achieved.

2.6.4.1 Criticisms of the BMC

Although the BMC is widely used in practice, some criticism has been made regarding it's ability as a tool with which to understand business models. Rosenberg *et al.* (2011), states that the fact that the BMC comes from an innovation background, it is inherently biased to innovation, rather than to understanding current business models. As a result the canvas does not consider issues such as organisational structure, objectives, performance measures, strategy, and competition.

Upward (2013) notes that the BMC - having arisen from neo-classical economics has a focus on profitability as the predominant metric of success, despite the fact that the definition of a business that underpins the canvas states that business models are about creating and capturing value in a more holistic sense. By focusing on profitability, Upward (2013) claims that the BMC has no scope to account the environment, or society, unless they are inherently linked to the way in which the business model generates revenue. If we return to the definition of the business model provided by Osterwalder and Pigneur (2010) and their accompanying BMC, we can see that companies striving for a competitive advantage through unique value propositions, such as sustainability, can use the configuration of their business models to execute their strategies on the market (Boons and Lüdeke-Freund, 2013). In the case of the Business Model Canvas, this means designing the building blocks of the canvas in such a way that the characteristics of sustainability can be adhered to, whilst remaining profitable. Boons *et al.* (2013) discuss the business model in this context, identifying three aspects of a model that are vital for sustainable innovation (Boons *et al.*, 2013):

a) The value proposition makes it explicit that the relationship between the firm and its customers is not built around a specific product or even a specific service, but rather by the exchange of value.
b) The configuration of value creation directly points towards the larger system of which the firm is part, both technically and socially, making clear that the activities of the firm are embedded in the larger system.
c) The distribution of costs and benefits points towards the requirement that all actors involved need to have a sound balance of costs and rewards.

2.7 Sustainable business models: summary

Pressures such as unsustainable levels of consumption of non-renewable resources (i.e. oil) and production of wastes (e.g. climate change), when combined with a growing and more prosperous global population, mean that current business practice by many of the worlds organisations is likely to be unfit for purpose. As such there is a requirement for the world's businesses to embed sustainability principles that may see them be able to do more, with less, and to continue contributing to the world's economy at less environmental impact.

The literature highlights a number of ways in which businesses may be able to move towards sustainability, and in ways that may lead to increased productivity, and profitability. Implementation of business models that may deliver such benefits are however beset by a number of barriers, that may differ on a sector by sector basis. One such example is that of the airport retail sector, a highly profitable industry embedded in a much wider industry – aviation – resulting in a multi-facet of complex issues. The following chapter describes these issues in more detail.

2.8 Airport retail: an exemplar of the Sustainable Development challenge?

2.8.1 Introduction

The air transport sector can be considered an exemplar of the Sustainable Development challenge. Over the past half century, it has facilitated considerable socio-economic benefits that have helped the world to develop, predominantly by enabling greater global mobility and providing accessibility for remote and island communities (Pailing, Hooper and Thomas, 2013). The continued development of aviation is however, coupled with increased environmental impacts, resulting from the fact that growth has been so strong that it has outstripped the sectors ability to deliver energy efficiencies and address its continuing reliance upon carbon fuels (Lee *et al.*, 2001). Continuing globalisation and economic development is forecast to drive significant further growth in air transport demand over the coming decades (Airbus 2015, Boeing 2015). However, the increasing pressures of climate change and peak oil has the potential to constrain the sectors ability to grow in response to demand, and to continue to deliver the socio-economic benefits that arise from it. This section discusses the aviation sustainability challenge in more depth, through examination of the specific case of airport retailing, highlighting the complex range of issues that are likely to influence the development of this specific sector in the future.

2.8.2 Aviation and Sustainable Development: a primer

Over the past five or six decades, aviation has changed the world in which we live. It has provided high speed mass transport over long distances, driven economic and social progress, connected people and cultures, created new patterns of trade and human migration, provided access to global markets, created the global tourism industry, and is employing many millions of people globally (ATAG, 2012). These positive influences have had such influence that many economies (local to national in scale) have become highly reliant upon the sector – particularly the case in remote geographical regions such as the UK (an island nation) on the geographical periphery of Europe (see for example, Airports Commission, 2013).

Air Transport has played a particularly significant role in the development of the UK because of its historical roots in the aerospace industry, its global political and economic influence, its comparative affluence and more recently, its multi-cultural society (Hooper, Raper and Thomas, 2010). The result is a sector that is deeply interwoven into the modern world, and on which many people rely - such that a high proportion of people in Britain now take it for granted that they will holiday abroad. In the UK, aviation contributes around 150,000 jobs directly, represents 38% of UK's extra EU trade, and generates some €9bn of economic output (DfT, 2011).

These socio-economic benefits have been facilitated by exponential growth of the aviation industry since the end of the Second World War, with scheduled traffic growth between 1992 and 2005 increasing at an annual average rate of 5.2%[25], in terms of revenue passenger kilometres[26] (Lee *et al*, 2009). This growth has been fuelled by a number of factors. Improvements in aircraft technologies, deregulation of the industry, the emergence of new low-cost airline business models, and changes in the economics of the industry (i.e. growing income from non-aeronautical sources) which have seen a significant reduction in the cost of flying. The result has been that flight has become a more accessible form of mobility for the public, and made the rapid transportation of high value goods over long distances economically viable. This growth is predicted to continue, with annual growth expected to average 4.8% globally to 2030 (ICAO, 2010) – and with much higher rates predicted in the developing nations (Owen *et al.*, 2010).

The operation of the air transport industry is however associated with a number of negative externalities, including in particular, the consumption of natural resources (particularly carbon fuels), and the release of a number greenhouse gases (GHGs) that contribute to climate change (Hooper and Thomas, 2013).[27] The particular challenge for the sector comes from the fact that that growth has, and will continue to outstrip technological and operational improvement, with the result that fuel consumption and carbon emissions from air travel are growing year on year, a trend that is unsustainable, economically, environmentally and politically (Thomas, Hooper and Raper, 2010).

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25 This growth has been driven by a fall in the relative cost of flying; a function of a number of factors, including; increased affluence of the public, relatively low price of fuel, the deregulation of the industry, increasing fuel efficiencies that have reduced airline-operating costs (Freathy, 2004).

26 A measure of traffic for an airline flight calculated by multiplying the number of revenue-paying passengers aboard the vehicle by the distance traveled (GAIP, 2015).

27 At a local level, these impacts are already constraining the growth of airports (Eurocontrol, 2013) but more importantly, at a global level, fuel consumption and climate change emissions threaten the longer term growth of the whole industry and therefore the role it will play in the global economy/society of the second half of the 21st Century (Hooper, Raper and Thomas, 2013)

In the context of peak oil (discussed in Section 2.2), increasing demand for a depleting resource has significant implications for the longer-term development of the industry. Fluctuations aside, peak oil issues have seen the price of oil consistently rise for over several decades (See Figure 2-14). Such costs have a direct and significant impact in the operating costs of airlines (IATA, 2014), which may respond by increasing ticket prices. Increased cost of flying can have a negative impact on sector demand, and thus limit the ability of the industry to continue to deliver the many socio-economic benefits for which it is responsible; thus, there is a clear imperative for the sector to decrease the amount of fuel it consumes.

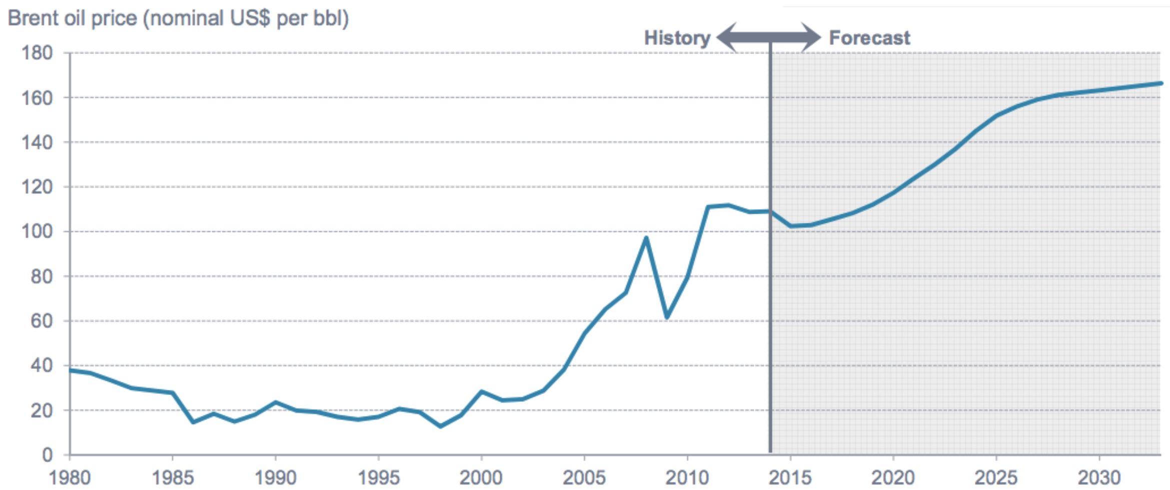


Figure 2-14; Historical and predicted cost of oil (Leahy, 2014)

Whereas other sectors have the opportunity to reduce their fuel use and emissions through a range of efficiencies and technological innovations, the aviation sector is held back by a number of issues, not least (McManners, 2012; Monbiot, 2007):

- Step change technologies that may reduce carbon output significantly are decades away. So aviation is likely to remain reliant on, and indeed be a legacy user of fossil fuels as a means of propulsion.
- Aircraft have long lifespans lasting many decades. For example, the recently manufactured Airbus A380 is likely to still be in use in the year 2070 (Tyndall Centre, 2005).
- Aircraft represent expensive investments for airlines, with an Airbus A380 costing about US$428m (Airbus, 2015). Such huge investments represent a significant barrier to airline fleet modernisation.

- Putting more efficient aircraft into the air requires extensive design, testing, licensing and manufacturing, at significant financial cost (Monbiot, 2007).
- Long lead-in times for techno-innovations to reach the sector mean that there is the constant risk of becoming quickly obsolete through new innovations. Risk is therefore high (Peeters *et al.*, 2009).
- Enhancing aircraft efficiency with current propulsion systems is an increasingly difficult process that delivers only marginal gains (ATAG, 2010), as illustrated in Figure 2-15 below.

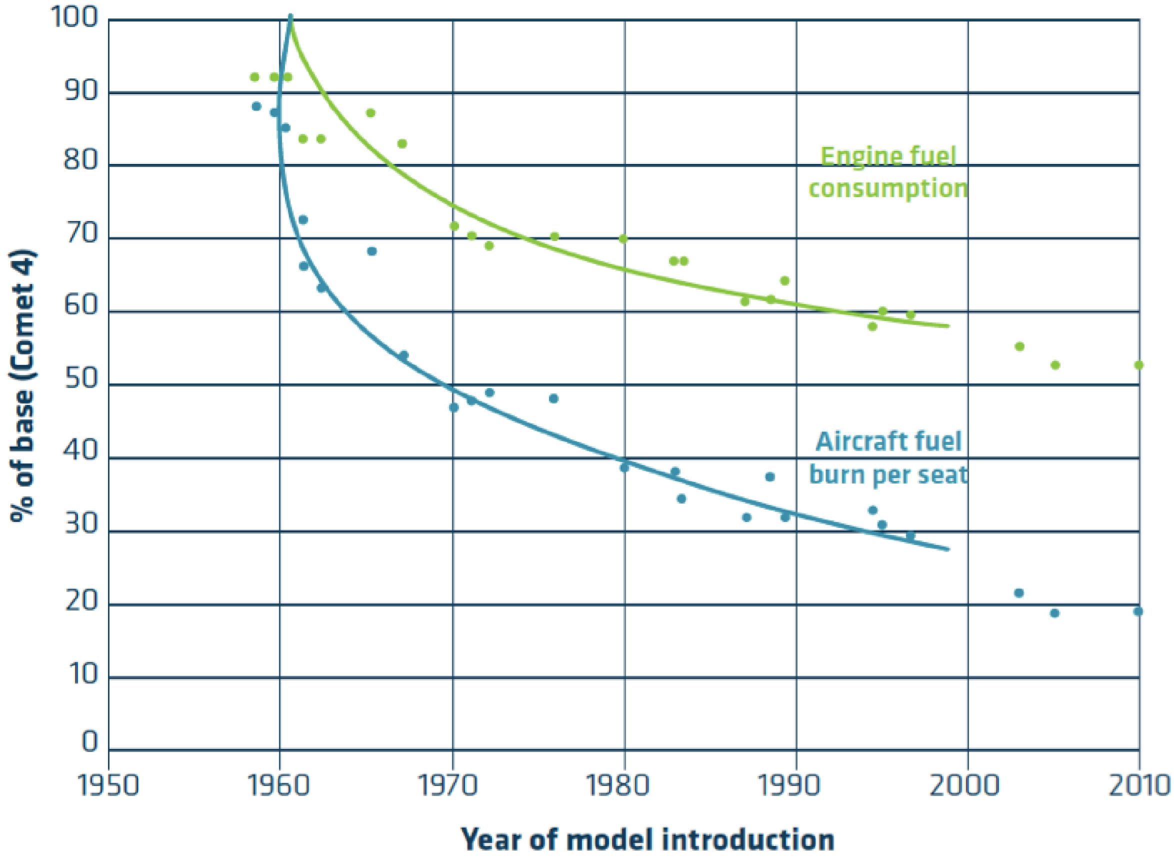


Figure 2-15; illustrating how technological improvements in aircraft fuel efficiency is getting more and more difficult to deliver (ATAG, 2010)

With regard to climate change, the combined radiative forcing[28] from aviation emissions contributes some 4.9% of all anthropogenic forcing globally (Lee *et al.*, 2009), with CO_2 from aviation accounting for 2.5% of global emissions in 2007 (ITF, 2010). Such levels may appear to be relatively small compared to other

[28] The change in average net radiation at the top of the troposphere which occurs because of a change in the concentration of greenhouse gas (GHG) or because of some other change in the climate system (Houghton, 2009).

sectors such as agriculture (13.5%) (IPCC, 2007); however on a global scale, compared to nations, the sector would rank as the 27th most polluting nation on Earth (ATAG, 2015). More importantly, their significance has to be set against the fact that only a small proportion of the world's population actually fly.

Despite the critical role that aviation plays in the modern world, air transport is particularly carbon intensive (due simply to the physics of flight) and it may therefore be incompatible with a future low carbon economy – as described previously in this Chapter. Equally importantly is the fact that air transport emissions are forecast to grow at a time when governments are seeking significant and rapid reductions in CO_2 to prevent dangerous climate change. In the case of the UK air transport sector, emissions will not decline by 80% as per UK Government targets (CCC, 2015), but by 2050 may simply return to levels found in 2005 (SA, 2012).

It can be confidently predicted therefore that the industry will face mounting pressures from a number of diverse sources that may act as constraints to growth in the longer term, including:

- legislation, such as the UK Climate Change Act (CCC 2015), or Swedish regulations that set limits for airport CO_2 emissions (ICAO, 2012).
- the introduction of market based measures such as the EU Emissions Trading Scheme (EC, 2015);
- growing environmental activism, such as the opposition mounted to proposal for the construction of a new runway at Heathrow airport[29] and calls to repeal the 1944 Convention of International Civil Aviation exemption on aircraft fuel taxation (see The Green Party, 2015; McManners, 2012; Monbiot, 2006).

For a variety of reasons, therefore, in the absence of more rapid technological advancement and operational improvements in the industry, it will be critical that all aviation stakeholders make every effort to develop, implement, and publically demonstrate the adoption of new low carbon business practices. It is in this

[29] http://www.theguardian.com/environment/2008/feb/25/climatechange.transport

context that the airport retail sector will need to address the full carbon implications of its current business model.

2.8.3 The place of retailing in the airport

There are three types of activity that occur in the airport; essential operational services, air traffic handling services, and commercial activities (Doganis, 1992). Commercial activities such as airport retailing can today be considered as synonymous with the airport environment (Freathy,1998), this has however not always been the case. The roots of the sector can be traced back to the World's first duty free shop at Shannon Airport, on the West Coast of Ireland, which was opened in 1947[30]. Since then, and until the 1990's, the sector was considered as something of an ancillary component of the airport in that it was often provided but rarely considered as an essential part of the airport system (Freathy, 1998).

Airports and airlines were originally state owned and funded elements of the transport system (Freathy, 2004) designed to facilitate the mass movement of people and goods (Doganis, 1992). In this model, airports saw passengers as part of the airline business rather than their own, resulting in only ancillary service provision to account for basic needs – accordingly, little attention was paid to profit maximisation from such activities (see Newman *et al.*, 1994). This picture changed however as a result of four key drivers:

- **Airport privatisation.** In the 1970s, governments looked to privatise the airport sector, as a means to avoid the financial burdens associated with airport subsidisation (with these funds being in competition with other public services (Freathy and O'Connell, 1998)). Privatisation allowed for private sector organisations to gain a financial interest in airport operations, enabling the state to maximise revenue while at the same time improving customer service and quality standards (Graham, 2009; Freathy, 2004).
- **Government regulations.** The privatisation of airports saw operators initially increase aeronautical charges to airlines, as a means to increase profitability (Doganis, 1992; Graham, 2009). In an effort to ensure that such charges would not constrain inbound tourism or trade and investment, government legislation (implemented in the UK through the Economic

[30] As the most Western airport in Europe, this was a popular destination for aircraft to refuel before crossing the Atlantic and so the first airport retail site was placed here to give passengers the opportunity to make purchases that would make their pending long-haul flight more comfortable.

Regulation of Airports Regulations 1997) (UK Government, 1997) was established to limit the fees that airports could charge airlines. This forced airports to seek new revenue streams from non-aeronautical sources.

- **The rise of the low cost carrier (LCC).** The liberalisation of the airlines in the 1990s (McManners, 2012), saw the arrival of the 'no frills' airline sector that saw operators grow rapidly from 3m European passengers in 1994, to 100m European passengers in 2004 (Doganis, 2006), based on their ability to operate highly efficient services with low costs for passengers (Calder, 2006). The growth of the sector proved so great that airports now compete against each other to attract such airlines (able to negotiate reduced aeronautical fees for operating at airports, under the proviso that they would bring the airport increased traffic). This has, however, seen the traditional fees charged to airlines remain relatively unchanged in recent years - leading to airport operators to seek out alternative sources of income (Freathy and O'Connell, 1998). The fact that airports are now reliant on passenger spend in the retail outlets as a key revenue stream means providing an attractive and extensive retail offering is now an essential airport activity.
- **The perception of value.** The increasing perception that Airport Retail, and specifically Duty Free, offer value to passengers compared to the high street has also helped to drive the sector at a time of increasing affluence and consumerism (Dallen, 2005; Freathy and O'Connell, 1998).

The result is that, in relative terms, aeronautical charges such as landing fees have not increased in recent years (Freathy, 2004). At the same time, airport operators have been able to consistently increase revenues from non-aeronautical activities to the point where retailing is a significant source of revenue for the majority of airports, comprising a wide range of sources (see for example Figure 2-16). For example, between 1976-1987, Frankfurt airport increased passenger traffic by 63%, but increased its retail revenue by 284% (Doganis, 1992). According to Graham (2009), globally, the growth of airport retail revenues has seen the sector increase from representing 41% of airport revenues in 1983, to 50% in 1998. Today, the retail sector represents one of the primary sources of revenue for airport operators, with Heathrow Airport alone generating an income through retail of some £503m in 2014 (Heathrow Limited, 2015). Indeed, the turnover for airports from retailing is so great that it could potentially be argued that without such revenues, airport operators could be forced to pass the burden onto the airlines.

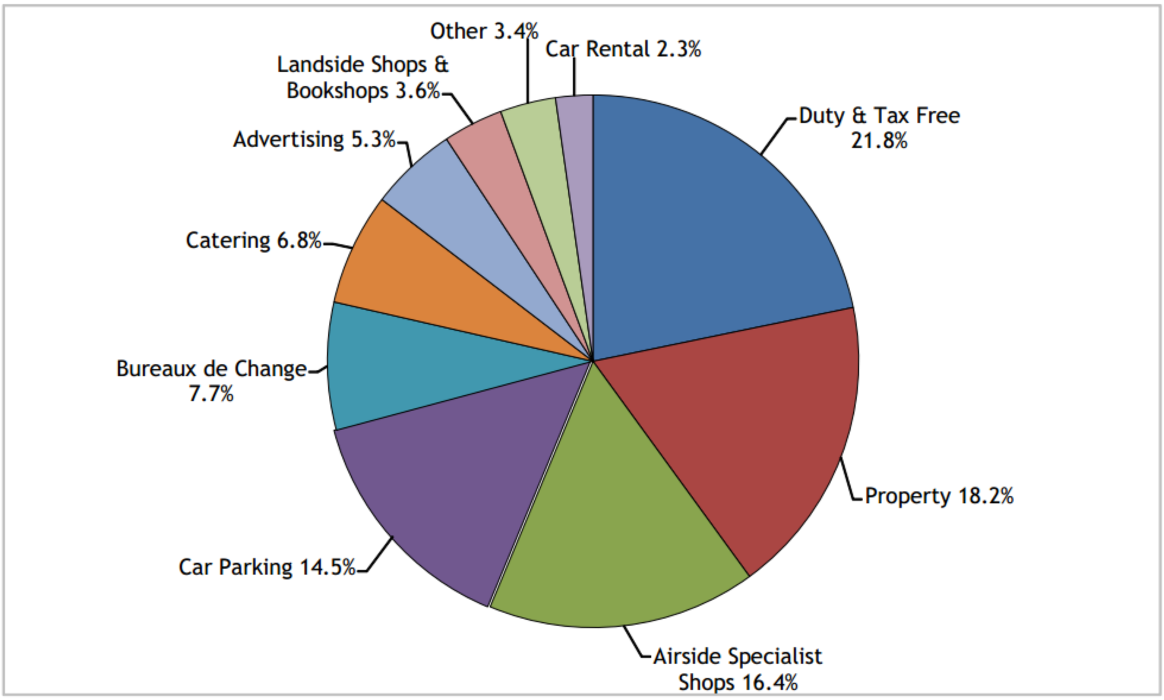


Figure 2-16; Heathrow Airport retail and property revenue mix 2012 (CAA, 2013).

Airports represent a noteworthy opportunity for retailers to generate profit, compared to 'high-street' retailing in that the location has access to a captive, cash rich audience (Fernie, 1995) – due to personal wealth or disposable income carried for leisure purposes (Kim and Shin, 2001). Importantly, such passengers also have much 'dwell time'[31] to fill in the airport, plus a psychological state of mind willing that is amenable to the idea of shopping (Bia, 1996; Bork, 2006; Freathy, 2004; Graham, 2008; Kim and Shin, 2001; Newman *et al.*, 1994). Such factors are also supplemented with advanced marketing activities and store layout designed to increase ones propensity to buy. Terminal Two at Manchester Airport for example now requires passengers to pass through a Duty Free outlet in order to reach the departure lounge of the airport to encourage impulsive purchasing (Moodie, 2015). These differences mean that whilst airport and high street retailers conduct the same fundamental activities of selling products to customers, the two

[31] Dwell time refers to the amount of time a passenger has between check-in at the airport, and departure from the airport. People spend on average 2 hours in an airport, but only 30% of this is needed for processing (Ashford *et al.*, 2013). The remaining dwell time is free for the passengers to use as they see fit. This is one of the primary factors in determining the profitability of airports as it provides passengers with much time to browse, to make both informed and impulsive shopping decisions, and to reduce the stress that results from passing through airport security (Kim and Shin, 2001).

are bound by a very different set of operational, commercial and regulatory conditions.

Accordingly, there exists a number of articles in the literature that consider the segmentation of airport passengers as a diverse set of well-informed groups who expect to fulfil a number of criteria during their shopping experience, depending on their segment (for example, Freathy and O'Connell, 2000; Sulzmaier, 2001; Geuens *et al.,* 2004; Dallen, 2005; Wagner, 2008; M1nd-set, 2014).

These include (M1nd-set; 2014):

- Finding something to do in the airport during dwell time.
- Having access to a wide range of products.
- Looking for 'local-touch' items from the local area.
- Finding luxury and exclusive brands.
- Finding bargains.
- Fulfilling emotional and psychological goals associated with shopping.
- Utilitarian shopping to stock up on their usual items.

The opportunities presented to retailers in terms of potential sales to these segments means that airport operators are able arrange a diverse set of secure, profitable, and long-term contracts with retailers, for example based on charging high rents for retail space, and through claiming a percentage of profits made on items sold[32].

M1nd-set (2014) also stress the importance of impulse purchasing in terms of the profitability for airport retailing, with many customer segments being particularly susceptible to this type of shopping. Crawford and Melewar (2003) found a number of factors that may have a positive impact on customers decision to make an impulsive purchase, these being; value driven, holidays, gifting, guilt, rewarding, special occasion driven, forgotten items, confusion, exclusivity, disposal, and disposal of foreign currency. From this the authors proposed that airports seek to reduce stress and anxiety[33], induce browsing, reduce normative

[32] See Kim and Shin (2001) and Doganis (1992) for more on the typical contract arrangements that exist between concessionaires and airport operators.
[33] See Volkova (2011)

traits, and promote ‘pure impulse’ as a means increase the propensity to impulse purchase.

The result of this changing landscape is that retail has become ubiquitous with the airport setting, with many airports viewed as high end retailing destinations in their own right, selling a range of luxury products often unavailable on the high street (Hobson, 2000). Examples being Dubai International Airport, Changi Airport in Singapore and Amsterdam’s Schiphol Airport, popular for products such as gold and jewellery, perfumes, tobacco products, furs and clothing, grocery and department stores (Hobson, 2000). The success of non-aeronautical revenues for airports enables means that the industry plays a key role in modern airport revenue portfolios. Indeed many airports market themselves on the diversity and quality of their retail offer (Hobson, 2000).

Airport retailing or ‘concessions’ include all commercial activities that result in the sale of goods and services in the airport (Doganis, 1992), with a number of different categories of concessionaire existing (Kim and Shin, 2001):

- Convenience stores, news-stands, pharmacy/drug stores.
- Speciality shops, book stores, souvenir shops, fashion wear, flower shops, hand craft, sports shops, electronic accessories.
- Duty Free Shops.
- Food and Beverage services.
- Passenger service facilities (lounges/bars).
- Leisure facilities.

As well as the enhanced ‘propensity to buy’ of airport passengers, airport retailers also differ from typical ‘high-street’ retail in that they are constrained by the space they have available for selling and storing of stock due to the limited floor space in airports (Freathy and O'Connell, 1998).

One of the largest segments of the airport retail sector is that of Duty Free[34] and tax-free retailing. This sector represents a complex industry where the boundaries

34 Regarding the operations in the European Union, in accordance with Directive 2008/118/EC, the duty paid regime applies if the passenger’s final destination is ‘domestic’, that is, a European Union member state, while the duty free regime applies if the passenger’s final destination is ‘international’, or outside of the European Union (WDFG, 2014)

between retailer, wholesaler, airport operator and manufacturer have become increasingly blurred (Freathy, 2004). Duty Free goods can be defined as goods purchased free of duties and import tariffs at the point where people depart a country - since the goods may not be consumed in the country where they are purchased (Dallen, 2005). As a result, such products can offer the customer a discount on the recommended retail price that they may have to elsewhere, increasing the propensity to buy. Whilst this enables products to be sold cheaply to passengers, it also acts as a constraint on duty free retailer activities in that the products they sell must be sold in the airside of an airport (post security) to ensure that they will pass through an international boarder. This limits the types of innovations to incumbent business models that retailers might otherwise consider. It also has secondary implications for airlines, as products sold in airport retail outlets are taken onto planes with a consequential increase in on board weight, fuel use and emissions, an issue considered later in this research.

The continued focus on profit maximisation by airport operators has seen the global duty free market grow to almost US$37bn in 2014, with a global average spend per passenger of US$6 (Verdict, 2014). This growth has survived potential threats to sales arising from issues such as international terrorism, disease pandemics such as SARS, and economic recessions (Steer Davies Gleave, 2013) that have impacted upon air transport demand. When one considers that an estimated 400-600 million passengers will pass through UK airports by 2030 (Freathy, 2004), and that a 1996 report by Mintel International shown that 70% of air passengers bought some kind of product in an airport, the potential future market for the Duty Free sector is clearly significant.

2.8.4 Retail operations in the airport

As described by Kim and Shin (2001), there are a number of different management strategies taken by airport operators towards retailing within the airport setting, ranging from direct operation by the airport operator, to wholly-owned subsidiary arrangements, where retail operations are provided by a concessionaire who run their own operation and retain their own profits. The most popular of these approaches is that of the master concessionaire (Kim and Shin, 2001). In this arrangement airports lease out the operation of their retailing offer to external businesses that has long-established brand images and know-how in selling and marketing products / services in retail, and in airports. Freathy and

O'Connell (1998) provide a useful illustration of the activity chain in this relationship (see Figure 2-17), through which it can be seen that the retailer acts to link the product supplier, the customer and the airport operator together, without each partner directly interacting with each other at any point.

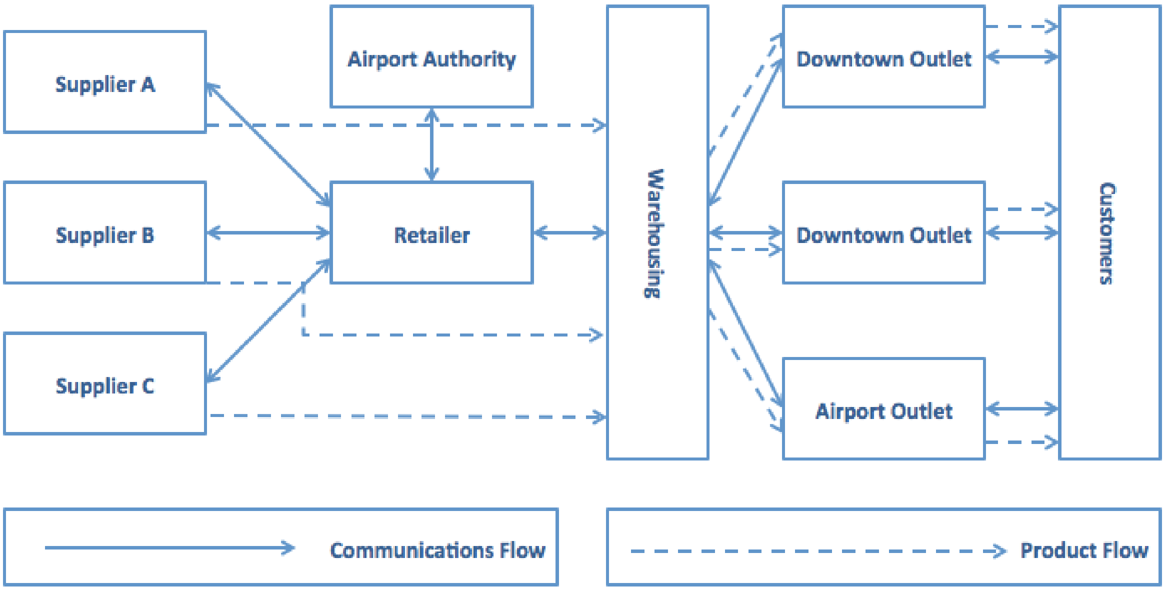


Figure 2-17; concessionaire-based retailing (Freathy and O'Connell, 1998).

Such relationships are common in many sectors where the principal (i.e. the airport operator), hires an agent (i.e. the retailer) to deliver a service based on their expertise in a given field. This can lead to 'Principal-Agent problems' and particularly to problems of 'split-incentives' - pertaining to situations where participants in an economic exchange may share different goals (IEA, 2007), making collaboration on a given issue difficult. In the case of the aviation sector, airport retailers, airport operators, and airlines are all acting within the same larger system, but with their own individual objectives. In the case of airport retailers and airport operators, this can be described as the 'landlord-tenant problem' (IEA, 2007) in which the landlord provides the tenant, with say utilities or appliances, for which the tenant must pay the operating costs. For example, an airport retailer may wish to use energy produced from renewable sources, but the airport may only provide cheaper non-renewably sourced energy. Sharma (1997) discusses this as a common Principal-Agent problem, stating that "agents are autonomous and are prone to maximising their own interests at the expense of principals" (ibid;759), thus there is a conflict of goals from an arrangement between the principal and the agent (IEA, 2007). Clearly from a sustainability perspective, such conflicts can potentially represent a significant barrier to finding low-carbon solutions to this challenge.

2.8.5 The implications of climate change and peak oil for airport retailing

As an active service partner of the airport, and an important stakeholder in the air transport sector, airport retailer operators have a clear role to play meeting the sectors commitment to addressing the threat to growth posed by climate change and peak oil. In this context, the industry can be seen to contribute to sector emissions in two primary areas.

- ***Airport energy use and carbon emissions.*** Growing pressure upon airports has given rise to the Airports Council International Airport Carbon Accreditation (ACA) scheme, with 85 airports registered in the scheme's 2013-14 annual report. The scheme, which is designed to encourage airport operators to engage with carbon reduction initiatives, makes provision for airports to register in one of four different levels, the highest being the attainment of carbon neutrality[35] (ACA, 2012). In 2013-14, 31 airports attained this status, thus having a vested interest in engaging with airport retailers to help achieve carbon reductions. Given that airport retail is a major consumer of energy in airport terminals (and therefore a producer of carbon emissions) airport operators will need to engage with their retail partners to secure carbon reductions, and so it may be in the best interests of airport retailers to develop their own climate change adaptation plans in anticipation. Similarly, retailers have the requirement of supporting government set CO_2 reduction targets for airports; an important issue as failing to do so could potentially result in constraints to growth in air traffic. This is perhaps best highlighted at Arlanda Airport, Sweden, which operates under a 'carbon cap' that limits airport capacity based on calculations of overall CO_2 emissions that must total no more than those produced by the airport in 1990 (Swedavia, 2013). In this instance, any carbon saving facilitated by the retailer may contribute to airport growth, increased passenger numbers, and therefore a larger number of potential customers.

[35] Describing the goal of achieving zero carbon footprint (emissions) by removing as much carbon dioxide (i.e. through carbon sequestration (i.e. planting trees) from the atmosphere as they put into it.

At the same time, retailers should also demonstrate a commitment to reducing carbon emissions and energy usage of airports so as to aide planning approval for airport development. This can be demonstrated through the focus on CO_2 that accompanied the ambitions of Heathrow Airport to build a third runway (see UK Government, 2015a). Additionally, airport retailers have the opportunity to gain direct bottom line cost savings by reducing energy provision costs, and avoiding payment of carbon 'taxes' such as, in the UK, the Climate Change Levy (UK Government, 2015b).As key partners, airport retailers can contribute to such efforts, and may find competitive advantage from doing so.

- ***Airline carbon emissions and fuel costs.*** Airlines are investing in a number of on-board weight reduction activities to reduce fuel use and associated costs and carbon emissions, for example, re-designing on-board trolleys, lighter cutlery, lightweight seats, unpainted aircraft, and reductions in in-flight entertainment (see Mason and Miyoshi, 2009 for a more extensive list of measures). As fuel prices rise, and climate change concerns grow, and should the industry struggle to meet carbon reduction targets - as presently forecast (ICCT, 2015) – airline attention could soon fall upon carry-on hand luggage arising from the sale of goods at airport retail outlets. Indeed the industry has previously attempted this through the now over turned 'one-bag rule', limiting the amount of luggage passengers could carry onto aircraft[36]. Whilst items sold at such stores may represent only small amounts of weight, the volume of sales made, combined with the high annual traffic movement of aircraft means that the combined impact may be significant. This is particularly important in light of the fact that the average improvement in fuel consumption between 1959 and 1995 was only 1.5% per year (Lee *et al.*, 2001), as compared to an annual growth rate of the industry of about 5% per year.

Peak oil and climate change have the potential to pose a direct threat to the incumbent airport retail business models, and it is of some urgency that the scale

[36] This resulted in losses of up to 40% at airports with a high proportion of Low Cost Carriers (Branquinho, 2010).

of this threat is determined and appropriate adaptation plans and potentially new business models be readied.

Additionally to the above, airport retailers face the same climate risks associated with high-street retailing; for example, resource scarcity (resulting in products becoming unavailable, or subject to price increases), or changing demographics (that could impact on the manufacture of goods due to global workforces shifting resulting from issues such as climate migration) (WRI, 2008). Likewise, rising energy and utility costs pose a threat to all retailer bottom lines (Accenture, 2012).

The direct and indirect environmental impacts (energy use and climate change emissions) that arise from airport retail, combined with the complex interdependencies of the aviation sector, mean that the longer-term sustainability of current airport retail business models could be called into question. From an economic perspective, airlines may benefit from the fact that airport retail acts as a profitable revenue source for airports. These benefits are however offset by the fact that airport retailing results in negative impacts upon airline fuel consumption and operating costs. From a political perspective, Governments seeking to reduce carbon emissions to prevent climate change, and NGO's opposed to aviation growth, may focus upon the fact that while airport retailing does not directly link to global mobility, it does have direct consequences for the emissions that arise from global mobility. This too however must be balanced against the demand from passengers for airport retailing, and for luxurious and high-end product ranges.

These factors indicate the need to consider whether new, more sustainable business model concepts, such as those discussed in Section 2.5 (which deliver the same profitability, but at less environmental cost) will be required by airport retailers in a future low carbon economy. This will particularly be the case if such sustainable business models become the norm as in other parts of the economy, as predicted by proponents of the sixth 'green' Kondratiev wave of innovation, as detailed in Section 2.4.1. If retailers are unable to adapt, their place in the air transport system may come under threat as new more sustainable sources of non-aviation revenue, are sought.

2.9 Summary

As illustrated in Figure 2-18, this chapter has reviewed a number of streams of literature that pertain to the research problem posed in the introduction. These have ranged from the market failures of capitalism, to the environmental pressures that have come about as a result, and the requirement for change from the worlds businesses to adapt in order for society to overcome these challenges. The chapter also reviewed these concepts in the context of the aviation sector, and specifically that of the airport retailing – the area of focus for this thesis.

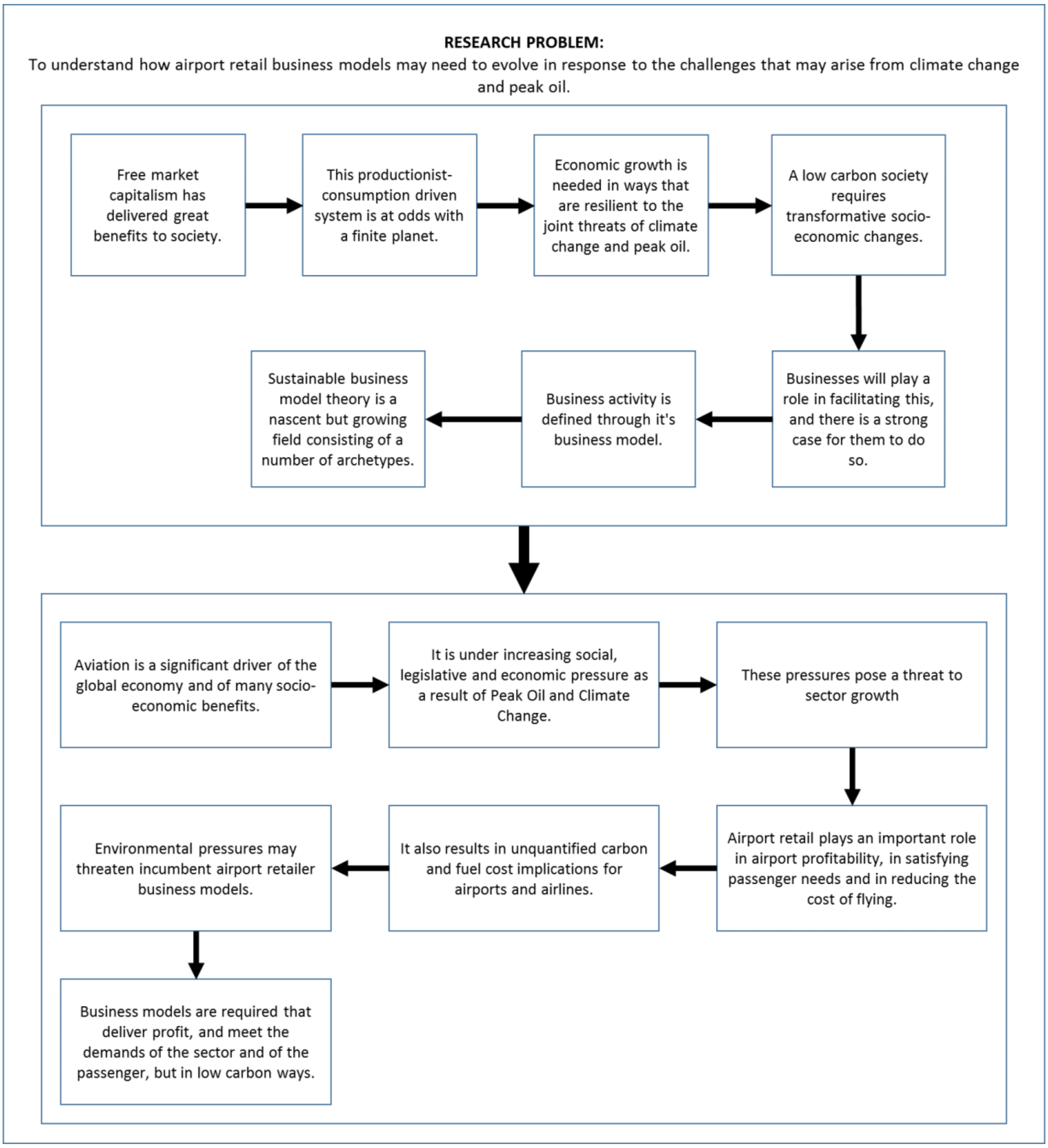


Figure 2-18; Sensitising Framework illustrating the streams of literature pertinent to this research.

A number of key conclusions can be drawn from this literature review. First, it is clear that airport retail is no exception to the ever-changing pressures of their operating environment. The world is a continually changing place and the parameters that define a businesses operating environment are constantly shifting. As such, all commercial organisations must look to evolve their business models in order to exploit current market conditions, and to remain commercially viable. This is true for those that espouse both the neo-classical and socio-economic theories of the firm, as discussed in Section 2.3.1 and 2.4.2 of this chapter respectively. Airport retail is no exception to this, and indeed has been subject to major changes in its operating environment on a number of occasions, not least the loss of the intra-European Duty-Free market and the introduction (and subsequent withdrawal) of the one-bag rule (CAA, 2013).

Second, it is increasingly likely that environmental issues will emerge as an additional threat to the sector in the future, and will define a new operating environment to which retailers will need to adapt. They will need to remain profitable, but through low-carbon business models that are able to mitigate the risks posed to their business through climate change and peak oil. Accomplishing this will require that retailers are mindful not only of their own pursuit of profit, but that they also take into account the expectations of, and consequences for their stakeholders, their customers, airport service partners, airlines, and wider society (in terms of potential implication any alternative business models might have on the cost of flying).

The ability of airport retailers to make strategic change towards sustainability is however dependent upon decision makers having appropriate information regarding;

- The risks posed to their business;
- The range of alternative, low-carbon business models;
- Which business models might be able to deliver a change that is commercially as well as environmentally sustainable.

To date there is a paucity of research related to the airport retail sector in a sustainability context. Therefore, this research aims to identify the need for such models, and to identify what the sustainable airport retailer of the future may look like.

3. Research methodology

This chapter explains and describes the methodology adopted for this research and details why the approach is appropriate for the research problem described in Chapter 1. The chapter first reiterates the research objectives, before describing the epistemological approach taken by the researcher, the overarching research methodology selection of Case Study Analysis, and the justification of a number of research methods. It then presents the Comprehensive Strategic Analysis framework used to analyse the research findings in the context of the airport retail sector. Finally, it discusses triangulation and ethical concerns.

3.1 Introduction

The design of a given study must link the initial research questions to the process of collecting, analysing, and interpreting data (Yin, 2003). Accordingly, and following the Sensitising Framework illustrated in Figure 2-1 in the previous chapter, this chapter details how the research meets each of the research objectives, via appropriate, robust and ethical methods.

An appropriate research design was determined by breaking down the overarching aim of the study; *"To better understand how airport retail business models will have to evolve in response to the challenges arising from climate change and peak oil",* into a series of more specific objectives, to:

- Research Objective 1; Understand the incumbent business model of airport retailers and identify the characteristics that differentiate the sector from other forms of retailing.

- Research Objective 2; Determine the environmental impacts and resulting economic costs of airport retailer business models for airport operators and airlines.

- Research Objective 3; Clarify how the carbon emissions and fuel cost implications of airport retailers may threaten the sector in the future.

- Research Objective 4; Identify what 'Sustainable Development' might look like for airport retailers.

- Research Objective 5; Understand how airport retailer business models can be adapted to the demands of a low carbon society.

The chapter first introduces the overarching research philosophy and multi-phase design developed to answer these research questions, through Case Study research within a leading airport retailer. It goes on to describe the specific methods used in the research, and how analysis will take place using Boardman, Shapiro & Vining's (2004) Comprehensive Strategic Analysis framework. Table 3-1 gives an overview of the research phases, the data collection methods and analyses utilised in each phase, and how these map against the research objectives

Table 3-1; An overview of the research design, and the application of research methods within Boardman, Shapiro and Vining’s (2004) Comprehensive Strategic Analysis framework.

Phase	Data Collection / Analysis Method	Analysis Stage	Research Objective	Relevant Chapter
1a) Engagement with organisation	Interviews about attitudes about sustainability in the business	Situational Analysis	1	Chapter 4
1b) Identify and analyse the incumbent business model.	Business Model Canvas Workshop	Situational Analysis	1	Chapter 5
1c) Quantify the scale of WDFG environmental impacts	Carbon Audit of direct emissions sources	Situational Analysis	2	Chapter 6
2) Identify the potential impacts of externalities on the incumbent business model	Analysis of the identified WDFG BMC	Situational Analysis	3	Chapter 7
4) Assess the situation of the organisation and identify the call to action	All methods used in previous phases provide the foundation for assessment.	Fulcrum Analysis	4	Chapter 7
5) Evaluation of alternative business models that may reduce the environmental impacts of retailer activities	Business Model Canvas	Solution Analysis	5	Chapter 7

3.2 Epistemological approach

“Different ways of viewing the world shape different ways of researching it”

(Crotty, 1998:66)

The way in which a researcher conducts research is dependent on their beliefs and how they understand the world (Gray, 2013). A range of different philosophical, theoretical and practical foundations exist, and the application of each in research design can result in varied ways of conducting research - and the data and conclusions that this derives (Gray, 2013). As such, it was vital to define the philosophical stance taken by the researcher, prior to designing the research. Additionally, this would help to identify pertinent methods that would help to bring about the desired research objectives that fit within this worldview.

Following the research objectives outlined in Section 1.2, it became clear at an early stage that this study would require the collection of both quantitative and qualitative data. Assessing the environmental impacts of WDFG activities would be, by its very nature, a quantitative process. Conversely, it was identified that as an organisation made up of individuals, relationships, structures, and processes (both physical and theoretical in nature), the research would also generate qualitative data.

Quantitative and qualitative methods have their own philosophical stances; typically, although not exclusively, these are deemed to be positivist and interpretivist respectively (see Table 3-2).

Table 3-2; The main epistemological positions found in quantitative and qualitative research (Adapted from; Orlikowski and Baroudi, 1991)

Position	Description
Positivism	Assumes that the researcher is detached from the research setting (Flick, 2006). In this epistemological stance, meaning, and therefore meaningful reality, exists separately from an individual's consciousness; its meaning is there whether we are aware of it or not (Crotty, 1998). Traditionally applied in quantitative research, it assumes that the world can be characterised and measured empirically using deductive, robust, repeatable, and ethically sound methods rooted in falsification or verification (Flick, 2006).
Interpretivism	Reality is a social construct in which the subject imposes meanings on objects; the object does not contribute to its meaning (Crotty, 1998). Essentially this states that meaning is constructed out of nothing by the researcher, and any findings made through study cannot be understood independent of the actors who make that 'reality', including the researcher. As such all knowledge is temporary, developmental, non-objective, internally constructed, and socially and culturally mediated (Twomey-Fosnot, 1996).

It was recognised that it would be necessary to reconcile the 'paradigmatic dichotomy' (Walsh, 2014) between the underlying philosophies of quantitative and qualitative methods before any data collection could take place. This was achieved through the use of a 'multi-method' approach to research which combines both qualitative and quantitative research and interpretive and positivist approaches.

Morse (2003) talks about the potential application of quantitative and qualitative research methods through a 'multimethod' design, that is;

"…the conduct of two or more research methods, each conducted rigorously and complete in itself, in one project. The results are then triangulated to form a comprehensive whole"

Morse, 2003, p190

This approach enables more than one worldview to be used in parallel with or successively within the same study. That is, to conduct positivist quantitative research, and interpretivist qualitative research together. This differs from the definition of a more traditional 'mixed method' research approach that describes the use of quantitative and qualitative data collection methods, under the same overarching worldview (Urquhart and Fernandez, 2013). Through multimethod design, the researcher is empowered to conduct quantitative research that complies with the scientific rigour demanded from such a philosophy, with the results obtained being tangible, evidenced, and replicable (Yin, 2011). At the same time, it is possible to conduct qualitative research that acknowledges that the results are socially constructed by those who interact with the research participants (including the researcher) (Yin, 2011).

3.3 Overarching methodology: case study research

As this research is rooted in a specific industry, comprising many organisations, and with many different actors, several different methodological approaches could have been appropriate. Based on the work of Yin (1994; 2009), Eisenhardt (1989), Darke *et al.* (1998) and Walsham (1995), a decision was made to pursue a case study approach as the primary research methodology.

Case study research is an accepted and valid method within the field of organisational research (Farquhar, 2012), due to it being able to facilitate the building of theories, the development of concepts, the drawing of specific implications, and to contribute rich insights to support, or counter, existing material within the literature (Walsham, 1995). Additionally, the approach empowers the researcher to use a combination of several different data collection methods, both quantitative and qualitative in nature (Eisenhardt, 1989). In the case of this specific research, the use of case study research as the principle research enable the:

- Observation and establishing of theories of how airport retailers operate;
- Quantification of the environmental impacts that result from these particular operational practices, and;
- Identification of what sort of concepts and activities could be introduced to improve the sustainability of the sector, and thereby the wider aviation industry.

According to Yin (1994), case study research is particularly useful in instances where a researcher is looking to “investigate a contemporary phenomenon within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident” (2003:13). Furthermore, it enables the researcher to study practices occurring within a case, whilst “retaining the holistic and meaningful characteristics” (Yin, 2009: 4) of the wider setting, thus making extrapolation of theory possible.

Due to sustainability and business models in airport retailing having received little attention in the academic literature, a case study method is ideal for investigating those businesses models in this setting, and their possible innovation. Thus, the use of the case study methodology can further be seen as valuable in that it can generate data about this field that other researchers may wish to replicate later (providing academic robustness). Furthermore, through generalisation, the methodology will provide context for other fields – namely other businesses; particularly those in the aviation and retailing sectors.

This research is revelatory in nature, in that it is investigating a nascent research setting. In this sense, it was determined that examination of a single case study organisation would be appropriate in answering the research objectives, as opposed to investigating the operations of a number of airport retailers. Single case studies, enable the researcher to engage with the research phenomena in greater depth, resulting in a rich and descriptive understanding of that setting (Darke *et al*., 1998; Walsham, 1995).

Yin (2009) noted a common criticism of case studies is their lack of rigour, with particular regard to generalisation from a single case study. The same author however, notes that theory should not be generalised from one case to another, but rather they should rather be compared to existing theory (Yin, 1994). Furthermore, Walsham (1995) states that four types of generalisation exist in interpretive case study research; generalising to case concepts, to an existing theory, to specific implications, and to rich insights. This research can be seen as fitting well with these generalisations in that it is carried out at a case organisation, with any theory developed being generalised to other retailers (airport based or otherwise), to a number of theories (be they related to business models or sustainability in general), in ways that may have specific implications for the wider aviation sector.

3.4 Research design

3.4.1 Scope and selecting cases

Selecting an appropriate organisation for investigation is an important aspect of case study research, and as such should be carefully thought out rather than being a random (Seawright and Gerring, 2008) or opportunistic (Benbasat *et al.*, 1987) process.

The goal is to choose cases that reflect the different characteristics and problems identified by the underlying research question (Yin, 1994), whilst being accessible to the researcher, and manageable, considering any logistical constraints that may bound that research.

Seawright and Gerring (2008) and Eisenhardt (1989) describe the approach to case selection on a continuum where the choice of a 'representative sample' lies at one end and a selection that demonstrate variations of 'polar types' lies at the other. Where a given study lies on this scale depends much on the research question. Similarly, as indicated above, the researcher must make the decision between single and multiple cases (Yin 1994). Eisenhardt (1989) states that case studies enable the researcher to focus "on understanding the dynamics present within single settings" that can "involve either single or multiple cases and numerous levels of analysis" (ibid;534). According to Yin (1994) single cases are appropriate in instances where the phenomena represents a critical case, where it is an extreme or unique case, or where it is a revelatory case, the latter of which is representative of this research.

In light of the above, a single case sample which is representative of the airport retail industry can be justified for this study in that it will enable the collection of data deemed to have relevance for the other retailers in the sector. Furthermore, as a new research field, the different scales on which airport retailers may view and approach sustainability is presently unknown, making ‘polar-sampling’ difficult. Finally, as a sector that is – as identified from the initial literature review - tightly bound by legislation, physical setting, and activities conducted, a representative sample would likely prove to have implications for theory across the entire airport retail sector.

The World Duty Free Group (WDFG)[37] is an appropriate case organisation for a number of reasons. Firstly, it represents a large, profitable, multi-national organisation with proven success in the field, as evidenced by the fact that it operates some 500 stores world-wide, and reports profits in the region of €2,406m per annum (WDFG, 2014). Secondly, whilst its headquarters are based in Madrid, Spain, WDFG is also the primary duty free operator in the UK, operating in 21 airports (including Manchester) and with a regional headquarters based near Heathrow Airport, London. This would facilitate the collection of data relevant to the company’s UK operations, through which inferences can be made regarding the wider scope of the organisations operations as a whole. Importantly, the organisation was willing to participate in the project by providing access to senior staff and the level of data required for the study to be a success.

The proximity of Manchester Airport (a major international airport serving over 22 million passengers annually) to the University made it a suitable candidate for detailed examination and use as an embedded case of the wider organisation of WDFG. The case study framework used in this study is illustrated in Figure 3-1.

[37] http://www.worlddutyfreegroup.com/

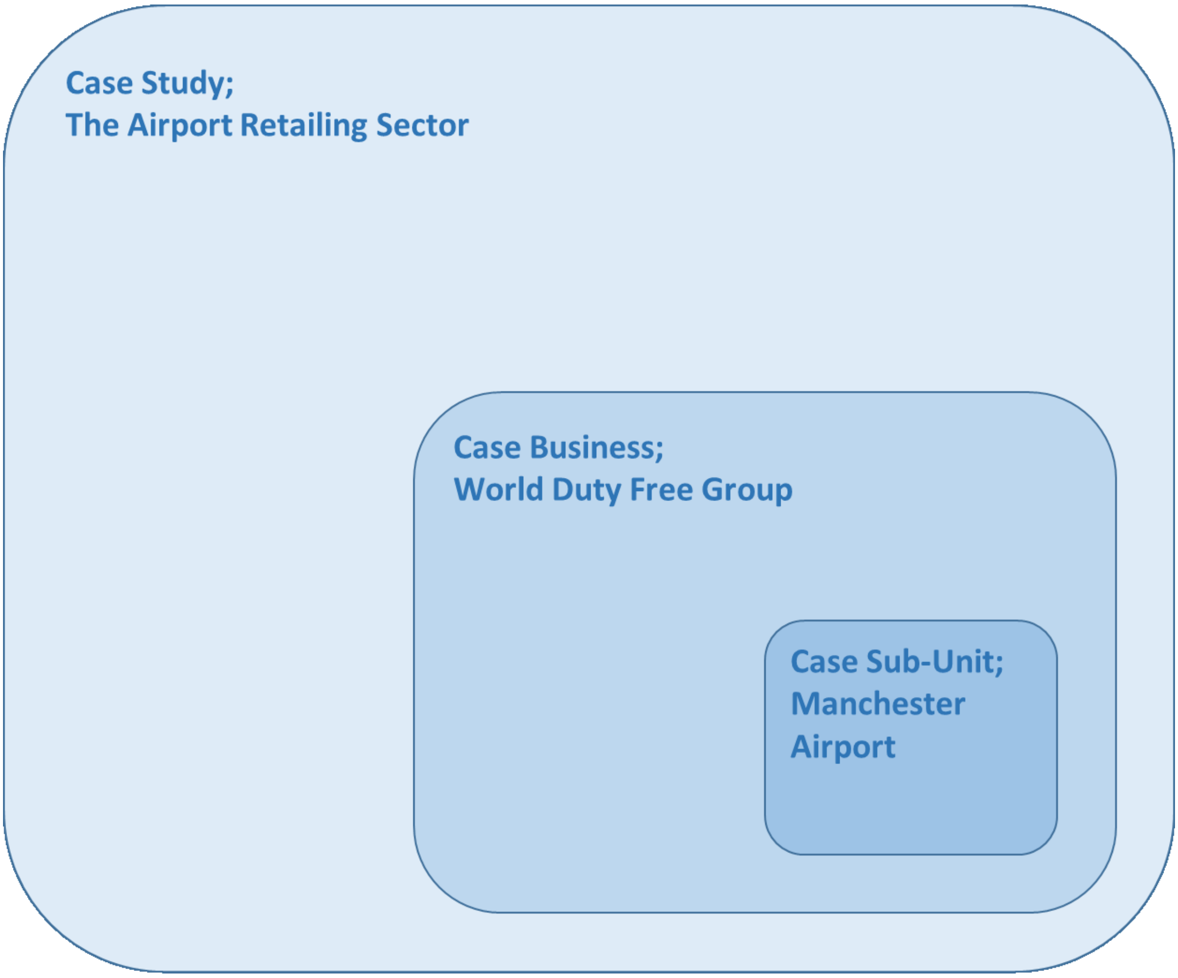


Figure 3-1; illustrating the embedded case study nature of the research

3.4.2 Phased research design

Based on identification of the research problem (the future of airport retailing in a low carbon world), the selection of the single case study method, and the pursuit of a deep, rather than broad investigatory approach, it became apparent that the research would benefit from a number of iterative steps; the results of each providing context for later phases.

- Firstly, there would be a need to engage with the organisation via an initial framing phase in order to obtain "buy in" to the project; that is, to establish trust from participant gatekeepers and stakeholders, and to gain an initial understanding of the nature of the firm in question – including the incumbent business model.
- With this understanding, it would be possible to identify the likely sources of carbon emissions arising from current WDFG business model operations and quantify the scale of such emissions.

- It would then be possible to examine and assess possible alternative (business models that would deliver with lower carbon consequences, that WDFG could use in the future.

As illustrated in Figure 3-2 and described below, this process was split into two distinct phases of research and analysis. Each phase was self-contained, with its own particular data collection method and underlying philosophy.

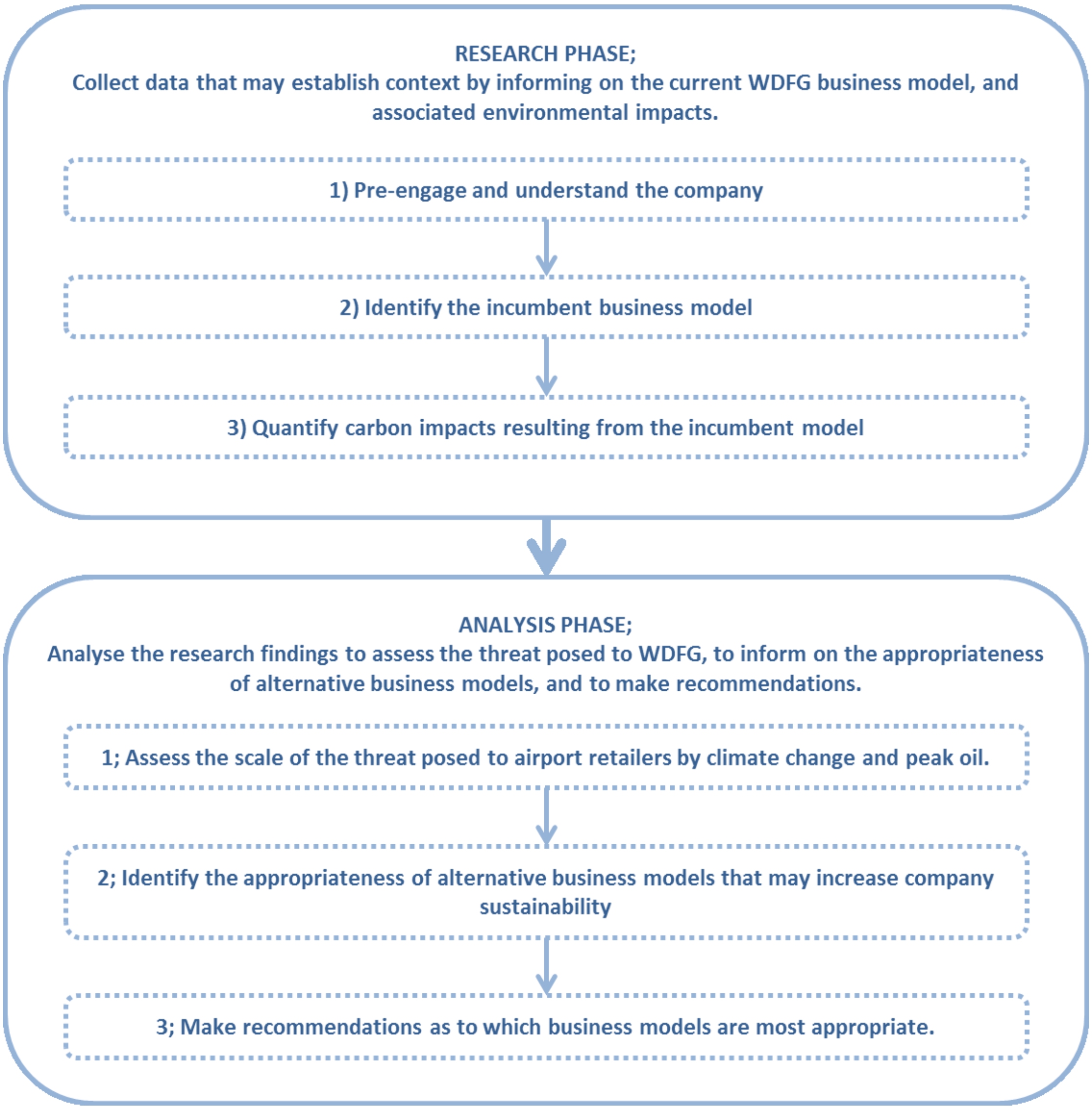


Figure 3-2; illustrating the multi-phased approach taken in this research

3.4.2.1 Research Phase 1: pre-engage and understand the company

The research commenced through engagement with the literature, starting with a preliminary review of the broad themes understood to be of relevance to the research problem, as proposed by Urquhart & Fernández (2013). Flick (1998) also describes this as important in case study research, as an initial theoretical underpinning can provide focus and direction to the researcher, as well mitigating the potential for the researcher to become overwhelmed by the vast amounts of data that may exist in their field. This 'phased literature review' would begin with a review of the background and place of airport retailing in the aviation sector, the challenges posed to society, and to this sector in particular, from the issue of climate change and the concepts of Sustainable Development.

This stage also presented an opportunity to engage with WDFG to develop trust and buy-in to the research project. This was achieved through regular face to face meetings, production of e-mail newsletters and briefing documents (addressing key issues identified in the literature review), and regular telephone conversations. Further detail of this dialogue and the presentation of the results to WDFG, can be found in Chapter 4.

3.4.2.2 Research Phase 2: identification of the incumbent WDFG business model

This phase of the research aimed to identify the incumbent WDFG business model and provide an in-depth understanding of the organisation. This was achieved by using Osterwalder and Pigneur's (2010) Business Model Canvas, as introduced in Section 2.7. The BMC was successfully completed via a well-received workshop attended by several representatives of the WDFG senior management team. The specific process, results and analysis are presented in Chapter 5 of this thesis.
Research Phase 3: quantification of the carbon impacts that result from the incumbent model

Identifying the WDFG business model in Phase 1b would provide an understanding of the type of activities that WDFG undertake in going about its business. Based on this it was possible to identify the potential sources and quantities of carbon emissions resulting from these activities. The process of calculating such emissions and the results are presented in Chapter 6. This Chapter includes calculations of emissions arising from the operation of the retail outlets in airports and the impact of products sold in WDFG outlets being taken onto aircraft. This latter assessment was particularly challenging due to a lack of any existing methodology.

3.4.2.3 Analysis Phase 1: assess the scale of the threat posed to airport retailers by climate change and peak oil

As identified in the literature review, business models are influenced by a range of externalities that a company must be able to respond to if it is to be successful in the long-term. The literature review also identified the pressing case of externalities in the aviation sector, and the fact that this may have an impact on airport retailers. Thus, understanding how such externalities may impact the WDFG business model is a vital component of the study that requires its own research phase. Accordingly Section 7.2 seeks to identify and understand the external environmental impacts that may influence the WDFG business model, as well as understand the strengths and weaknesses of the model relating to such impacts, and the opportunities and threats that they may pose for the business. This approach is recommended by Osterwalder and Pigneur (2010) as part of BMC innovation exercises.

3.4.2.4 Analysis Phase 2 and 3: identify the appropriateness of alternative business models that may increase company sustainability, and make recommendations.

Based on the previous phases, and the sustainable business model archetypes identified by Bocken *et al.* (2014), this phase would look to assess the appropriateness of alternative business models that could help WDFG and other airport retailers meet the sustainability challenge. From this the researcher makes recommendation as to which business models are likely to prove the most appropriate for the sector, as well as other broad recommendations. The results are presented in Section 7.4.

3.4.3 Data collection methods

Case study researchers often combine multiple data collection methods (Eisenhardt, 1989; Yin, 2003), and, as an interdisciplinary piece of research, involving both quantitative and qualitative data, it became clear that this research would require a number of methods of investigation in order to answer the research problem.

3.4.3.1 Documentation analysis

Document analysis was primarily used in this study to provide background information regarding WDFG for use in Research Phase 1, and to supplement other research methods. This is a common application of the method, for example as found in sports management literature (Edwards and Skinner, 2009). The method represents an unobtrusive way of researching an individual or setting (Hoggart *et al.* 2002), as data can be collected with or without the participant's knowledge, so long the researcher has access to an adequate data set. A number of materials can be used in document analysis, for example; letters, shareholder reports, memorandums, presentations, and other corporate documents (Bryman, 1989). Furthermore, the ability to review such materials in this way can help a researcher to become informed about an organisation without the direct involvement of the research participants. This has the benefit of minimising time requirements from participants - particularly important in situations such as this study where available time from WDFG senior management was identified as being limited.

3.4.3.2 Semi-structured interviews

Interviews are a popular research method in qualitative research projects (Flick, 1998), with Yin (2009: 106) stating that they are 'one of the most important sources of case study information'. Three types of interview are generally recognised in the literature: structured, semi-structured and unstructured (Brewerton & Millward, 2001), all of which have a number of benefits;

- Provision of rich data, preserving the original meaning of participants.
- Flexibility in terms of point of application, combination with other methods and the types of questions to be asked of participants.
- The availability of the interviewer, during the method itself, gives the participant the opportunity to ask their own questions, whilst the interviewer is able to probe for adequate answers where none are given, or to ask follow up questions that come to light.
- It is a co-operative process between the researcher and the participant, helping to establish buy-in to a project.
- It can deliver rapport with the participant, which may help to reveal otherwise inaccessible data.

Each type of interview has a number of strengths and weaknesses for qualitative research as detailed below (Brewerton & Millward, 2001). It was determined that semi-structured interviews would be most suitable for this project based on their ability to let the researcher create a broad structure of questioning prior to the interview taking place, based on initial theories developed through previous research stages. They also enable the researcher to be flexible in response to information that comes to light, asking new questions where appropriate, whilst also giving the participant the ability to answer in their own terms and in their own language (Flick, 1998). Un-structured interviews were deemed unsuitable for data collection due to their ability to miss key information (Gelissen, 2012), whilst fully structured interviews were considered inappropriate due to their inflexibility (Gelissen, 2012).

Semi-structured interviews were conducted throughout the project, but predominantly during the Pre-Engagement phase of the research (presented in Chapter 4). The aim of these interviews was to act as a means through which the researcher could gain an understanding of the organisation, which would aide in providing vital context to inform the later phases of the research. For example, at an early stage, the researcher interviewed the Business Relations & External Affairs Director and the Group Brand Manager in order to gain an initial understanding of the WDFG business, it's corporate and strategic priorities, and its approach to sustainability. Later the researcher would conduct a number of interviews with the Health, Safety and Environment officer in order to understand the pro-environmental activities conducted by the company, whilst also informing on how data could be obtained to inform the researchers calculations, presented, in Chapter 6. Interviews with the organisation's segmentation officer, a data extraction officer, and key members of staff at the MAN terminals would also help to inform the researcher with vital contextual information that would prove essential throughout the closing stages of the research.

3.4.3.3 Focus groups / workshops

The BMC has its own specific methodology (detailed in Chapter 5), however there are strong similarities between it and the similar method of the focus group, in that all involve the concurrent questioning of a number of participants, in order to develop a shared understanding of a given subject matter (see Osterwalder and

Pigneur, 2010; Morgan; 1997). Indeed one may posit that the BMC workshop process advocated by Osterwalder and Pigneur (2010), and explained in detail in Chapter 5 is not a form of focus group in itself, albeit one that follows a specific framework to guide the researcher.

Focus groups reflect a human-centred approach to research and is a useful method for both uncovering information regarding a particular setting, and an understanding of how the individuals in a given environment think and act (Morgan, 1997).

Converse to individual 'face-to-face' interviewing methods, focus groups represent a more active and dynamic research method in which an aggregate understanding of a setting may be acquired (Morgan, 1997) - something useful when an organisation comprising many processes, segments and individuals is under investigation. In the present case, we are trying to understand the WDFG business as a holistic whole rather than investigating different departments, piecemeal, and then stitching the data together. The BMC conducted as workshops/focus groups provides an opportunity for such investigation to occur.

Morgan (1997) recommends undertaking three to five focus groups. In this instance just one focus group would take place, in line with Osterwalder and Pigneur's (2010) suggested methodology, and based on the fact that the BMC process would require a selection from a small number of senior managers from WDFG to whom access was limited. In terms of number of individuals per focus group, Raibiee (2004) recommends between six and ten participants. Accordingly, a total of 8 participants were invited to attend the focus group, assuming that some may not be able to participate due to other commitments. The final focus group comprised a total of 5 participants (limited by sickness of one of the attendees). Such purposive sampling is a standard technique in focus group research as recommended by Miles and Huberman (1984).

The approach recommended by Gibbs (1997) for those moderating focus group situations was selected, with the researcher adopting the following roles as group facilitator:

- *To clearly explain the purpose of the interview and to put participants at ease;* achieved through a short presentation at the beginning of the process to introduce myself, the research project, and the BMC.
- *To ask open questions, to challenge participants and to probe for details;* achieved primarily by the BMC elements that would see a broad question raised, based on each element, followed by probing questions as appropriate.
- *To keep any conversation relevant;* again achieved through the BMC canvas as a framework for the study.
- *To ensure that all participants have the opportunity to contribute to the dialogue;* achieved by giving participants ample opportunity to get involved, through direct questioning where appropriate.
- *To remain impartial and to avoid providing personally held opinions;* accomplished by taking a neutral stance throughout the interview and by sticking to the BMC elements as a means of extracting pertinent information.

By adhering to such protocols it was possible to ensure the BMC workshop would run smoothly, provide all participants in the session with an active voice, and to adhere to the timeframe allotted for the activity. The BMC would prove a vital part of this process and be a significant success, by providing broad guidance for what questions to ask, and when to move from one BMC element to another, once it was felt that discussion had been exhausted. Details of how the focus group was performed, including a list of participants, questions asked, and outcomes, can be found in Chapter 5.

3.4.3.4 Carbon accounting

Carbon accounting has become one of the main tools by which to assess environmental impacts at an organisational level, with the GHG Protocol (WBCSD & WRI, 2004) providing as a robust, and regularly updated framework with which to do this. This involves identifying key activities associated with the operation of an organisation and then calculating the direct and indirect carbon emissions from each. Accordingly, this framework was applied in the research to understand the carbon implications of WDFG, based primarily upon the direct impacts associated with the operation of their retail outlets, but also the carbon consequences of products sold in WDFG outlets being taken onto aircraft. Further background regarding the carbon accounting method used is provided in Chapter 5.

3.5 Using Comprehensive Strategic Analysis as a framework for thesis findings.

As evidenced throughout this chapter, this research utilises a number of strategic business tools, frameworks and protocols. Combining and analysing such methods in a holistically manner can thus be seen as lending robustness to the research.

A number of tools exist against which an organisation can be analysed, however as Boardman, Shapiro & Vining (2004:p1) point out “the existing strategy literature is good at providing specific concepts and tools of analysis, but is weak in integrating the elements in a useful, systematic way”. This can result in difficulty for strategic researchers and practitioners in performing a detailed analysis of a firm and its operations. It is believed that this is particularly true of sustainability-orientated research, which the literature review has shown to be a much more nascent field, than broader business analysis, but with an equally diverse set of specific analytical tools.

Accordingly Boardman, Shapiro & Vining (2004) developed the framework known as ‘Comprehensive Strategic Analysis’ (CSA), which “contains and describes the major components of strategic analysis, and suggests an order in which they can be presented” (ibid:p1). CSA uses a range of tools commonly associated with organisational research; however it places them into a holistic framework comprising three consecutively approached phases that together can be seen as being more useful, efficient and practitioner-friendly than approaching strategic analysis in an ad-hoc manner. As illustrated in Figure 3-4 below, there are three primary phases of the framework.

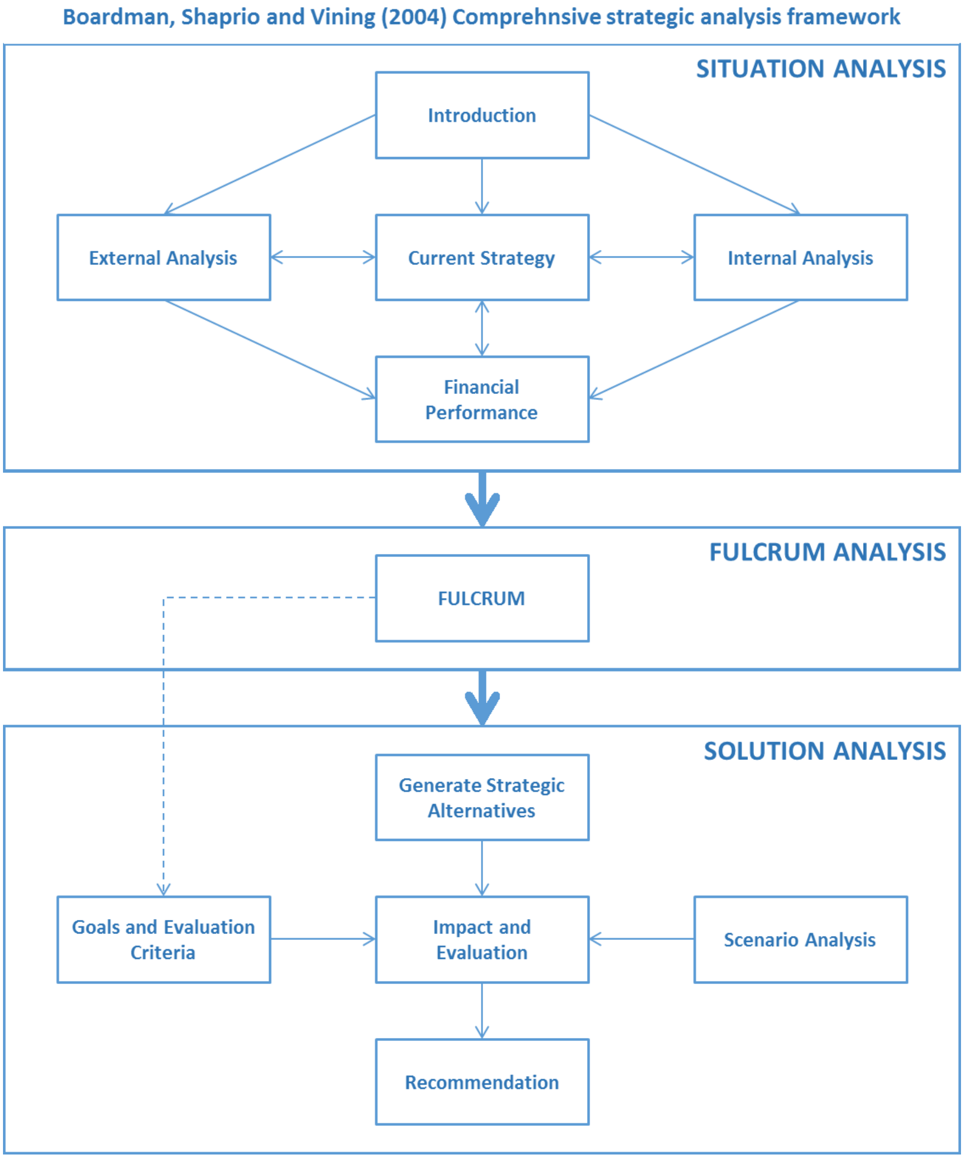


Figure 3-3; illustrating Boardman, Vining and Shapiro (2004) Comprehensive Strategic Analysis framework.

Each of these phases helps to inform on its successor by providing context that will eventually result in the most appropriate recommendation being identified:

- Situation Analysis: describes and analyses the current situation of the firm, through an introductory framing of the problem, an internal analysis, an external analysis, a review of current strategy, and a review of the financial performance of the firm. In doing so, this provides an in-depth background into the current scenario in which the firm operates.
- Fulcrum Analysis: Situational Analysis is summarised and a prediction is made as to what may happen to the firm should current practice continue unchanged, and thus providing a rationale for action. It also narrows the range of strategic alternatives that may be advocated for the firm, providing a broad strategic direction for the firm to move in.

- Solution Analysis: the researcher develops and evaluates strategic alternatives for a firm, with recommendations being made as to what are the most appropriate.

The CSA framework clearly has a number of synergies with this research in that it looks to deliver solutions to a given problem that are informed by the internal and external characteristics of an organisation, resulting in appropriate recommendations being made. In particular, it was noted that there are significant similarities between Situation Analysis, and the phased research design that had been planned for the research project (as illustrated in Figure 3-2 above). That is; obtaining an initial understanding of the firm and an external analysis (Research Phase 1), and understanding its internal characteristics (Research Phase 2), understanding its environmental performance (rather than financial performance – Research Phase 3 – see below).

Furthermore, Fulcrum Analysis, and Solution Analysis would act as secondary layers of analysis that would permit the analytical phases of the research to be conducted, whereby the relevant ‘call to action’ for WDFG could be identified, and appropriate alternative approaches could be assessed.

Upon detailed examination of CSA, it became clear that it would be necessary to modify the approach advocated by the authors to better suit the specific aims of this study; that is to use the framework with a Sustainable Development perspective. This would require adhering to the sustainability principles set out in Section 2.5. The researcher felt that the existing CSA framework was aligned to neo-classical, profit centric economics and so did not permit the level of Sustainable Development analysis required for this study. Accordingly, the researcher modified the framework to better suit the aims of this thesis – as described below. Adapting the CSA framework in this way is supported by Boardman, Shapiro & Vining (2004) who state that the different nature and goals of a given industry or particular organisation mean that the framework can be approached in a flexible manner, as appropriate to each case.

It is believed that by adapting the CSA framework towards a Sustainable Development context, this would also result in making a significant contribution to the academic literature. To date, the CSA framework is under-analysed in the literature, and there has been, no attempt at re-orientating it towards Sustainable Development. The modifications of the framework can be summarised in Figure 3-4 in which the differences from Figure 3-3 are apparent. The following sections introduce how the CSA framework has been applied in this research, with Table 3-3 to Table 3-5, summarising the process used.

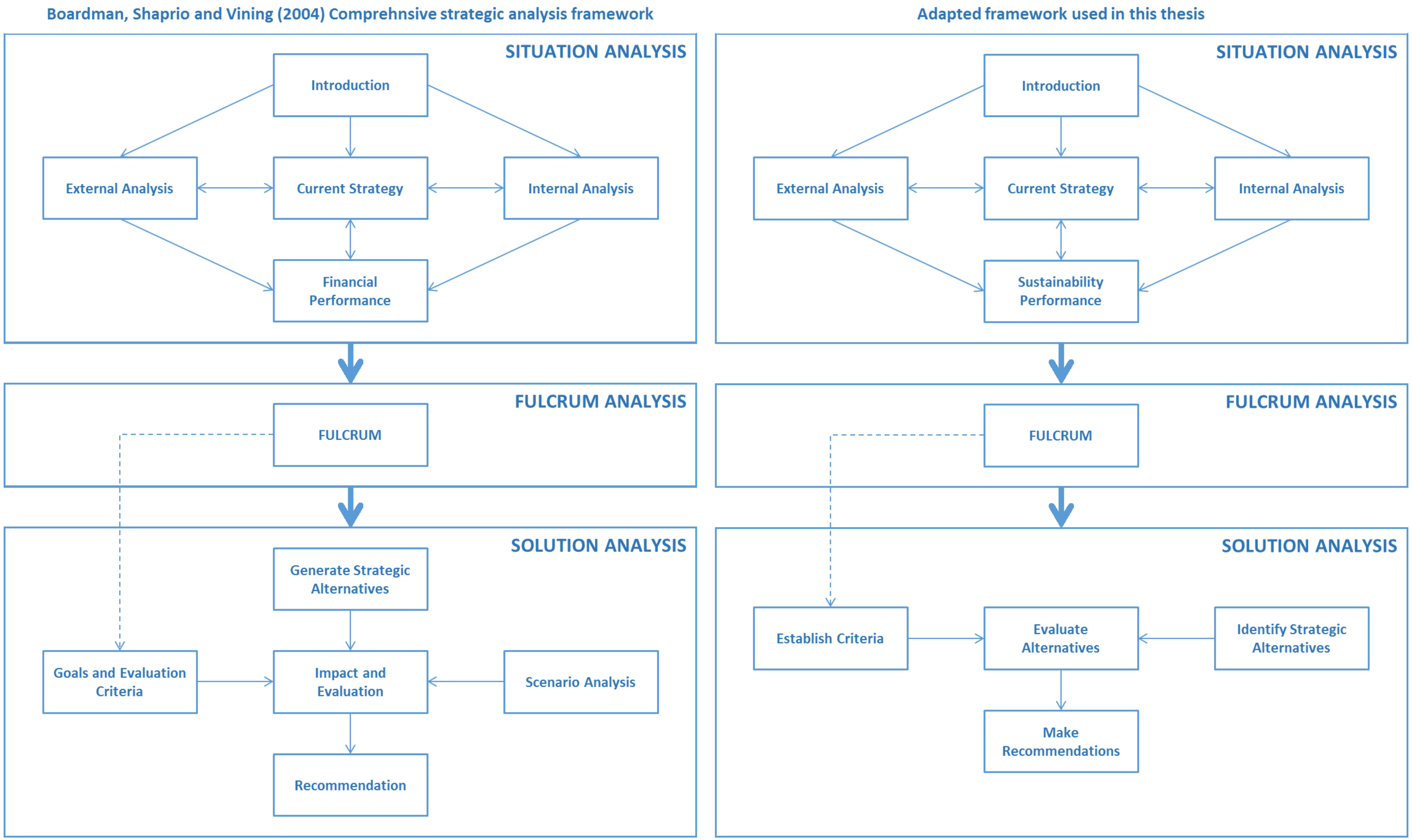


Figure 3-4; illustrating the original and adapted version of Boardman, Vining and Shapiro (2004) Comprehensive Strategic Analysis framework used in this research.

3.5.1 *Situation analysis*

Boardman, Shapiro & Vining (2004) view Situation Analysis as describing and analysing the current situation of the firm, through an introductory framing of the problem, an internal analysis, an external analysis, a review of current strategy, and a review of the financial performance of the firm. In doing so, the researcher is provided with an in-depth understanding of the research setting that can provide vital contextual data to ground the rest of the research. Situational Analysis follows the Structure-Conduct-Performance paradigm of the firm (see Porter, 1980), in that a firms overarching structure is first outlined, followed by an analysis of the actions the firm conducts within that structure, and the resulting performance of the two. The Situational Analysis as used in this research is summarised in Table 3-3 below, together with a list of what data sources and methods are driving each analytical phase. This follows the original CSA framework, with the exception of Sustainability Analysis replacing the Financial Analysis stage. The researcher determined that Sustainability Analysis was missing from the original framework – yet highly relevant for the present research. Furthermore, WDFG could be analysed from a financial perspective as part of the internal analysis and introduction phases.

3.5.2 *Fulcrum Analysis*

The 'Fulcrum Analysis' phase of CSA summarises the Situational Analysis, and predicts what may happen to the firm should current practice continue unchanged. It serves as the bridge between the Situational Analysis and Solution Analysis, thus providing a rationale for action (Boardman, Shapiro & Vining, 2004). It also narrows the range of strategic alternatives that may be advocated for the firm, and provides a broad strategic direction that the firm may consider moving towards. The framework details three main steps in Fulcrum Analysis that sees researchers summarise and asses the current approach of the case firm, concluding whether this approach is suitable for the predicted future environment in which it will operate: in doing so providing a sense of strategic direction. The process to fulcrum analysis taken in this research is summarised in Table 3-4 below.

Table 3-3; How Boardman *et al*. (2004) how Situational Analysis was applied in this research			
Analysis Phase	Description	Data Presentation Chapter	Data Source / Method
Introduction	Provide a brief historical overview of the firm and explain the purpose of the analysis. Provide some contextual information about the focal firm including ownership and control, corporate scope and a broad idea of the product-customer matrix.	Chapter 2; Literature Review	Literature Review
		Chapter 4; Engagement / Background	Semi-structured Interviews / Document Analysis
Current Strategy	Describe the current strategy of the business unit and the firm.	Chapter 4; Engagement / Background	Semi-structured Interviews / Document Analysis
Internal Analysis	What is the company's business model, what are its activity and value chains?	Chapter 5; Business Model Canvas	Business Model Canvas Workshop
External Analysis	Define the broad industry in which the business sits. What are its state and characteristics? Is the industry attractive or not?	Chapter 4; Chapter 4; Engagement / Background	Semi-structured Interviews / Document Analysis
Sustainability Analysis	Understand the company's position in terms of sustainability. How does the business positively and negatively contribute to sustainability? What signs of sustainability are present in the existing business model? What sort of initiatives and activities are the company doing to improve its sustainability performance? How do sustainability threats identified in External Analysis threaten the business?	Chapter 6; Environmental Impacts	Carbon and Fuel Burn Impact Calculations
		Chapter 4; Engagement / Background	Literature Review / Semi-structured Interviews / Document Analysis

Table 3-4; The components of Fulcrum Analysis used in this research			
Analysis Phase	Description	Data Presentation Chapter	Data Source / Method
A summary of the current and expected future performance of the firm	Draw on the Situation Analysis and consider questions such as: Is the industry attractive? Does the current strategy fit the external environment? Are the firm's activities and attributes appropriate for this environment?	Chapter 7.2.1; Fulcrum Analysis	Chapter 7.1; Situation Analysis
A statement of strategic direction.	Based on the previous stages of Fulcrum analysis, the researcher identifies the strategic direction and intent that the firm may need to take to remain profitable in the predicted future scenario they are likely to be placed in. This may point towards a limited or potentially large number of potential alternative business models, depending on the specific setting, the firm, and the predicted future environment.	Chapter 7.2.2; Fulcrum Analysis	Chapter 7.1; Situation Analysis

3.5.3 Solution analysis

The Solution Analysis phase of the CSA framework sees the analyst develop and evaluate strategic alternatives for a firm, with recommendations being made as to what are the most appropriate. Boardman, Shapiro & Vining (2004) state that this is one of the main benefits of the CSA framework, as it is an area not explicitly developed in the literature, particularly regarding how different alternatives can be created or evaluated. Solution Analysis is comprised of five components, however the researcher adapted this process to more accurately fit the objectives of this research – resulting in four components. Generating strategic alternatives was accomplished by using Bocken *et al*. (2014) sustainable business model archetypes as a means by which sustainable business models that are emerging in industry could be applied to WDFG. As a result this component was removed from the framework. These alternatives were evaluated against criteria identified in Fulcrum Analysis so that appropriate recommendations could be made – essentially the same process advocated by Boardman, Shapiro, and Vining (2004). Table 3-5 details these processes in more detail.

Table 3-5; How Solution Analysis was conducted in this thesis.

Analysis Phase	Description	Data Presentation Chapter	Data Source / Method
Establish Criteria	Identify criteria the potential new strategic options for the company must adhere to in order to meet the call to action described in Fulcrum Analysis.	Chapter 5.2.3 (Table 5-3)	Chapters 3-5
Identify Strategic Alternatives	Here a range of alternative business models should be identified so that they may be assessed against the above criteria.	Chapter 7.2; Fulcrum Analysis	Chapter 7.1; Situation Analysis
Evaluating the alternatives	The alternative models generated can now be compared to the identified criteria that they must match.	Chapter 7.2; Fulcrum Analysis	Chapter 7.3; Solution Analysis
Make Recommendations and Conclusions	Make recommendations to the focal firm by presenting the different alternatives for the research participant, and their appropriateness for the company objectives, and the predicted future operating environment identified.	Chapter 7.3; Solution Analysis	Chapter 7.3; Solution Analysis

3.6 Triangulation

Triangulation is an important part of a research methodology, with Easterby-Smith *et al.* (1991) referring to it as the process of collecting data over different times or by using multiple methods, whilst Miller and Brewer (2003: p326) define it as the ‘combination of different methods, methodological perspectives or theoretical view points’ within a single study. The triangulation of multiple methods is important in a research project in that it “pave(s) the way for more credible and dependable information” (Decrop, 1999: p159), with the ability to enhance the overall quality of a research project via one method’s strengths making up for the weaknesses of another complimentary method (Arksey & Knight, 1999).

Such triangulation ensures that more than one line of inquiry can occur in the research, with the goal that each leads towards a converging and holistic view of the research setting (Yin, 2009). This can enhance the robustness, and trustworthiness in a research piece by giving readers assurance that the results from research have been counter referenced against other methods to ensure that the results presented are comprehensive, and free from bias (Decrop, 1999).

The researcher believes that this has been achieved through the multi-method approach described in Section 3.4 in which the different methods used compensate for weaknesses in each other (Marshall and Rossman, 2011). For example, in order to understand the incumbent business model of WDFG, informal information gathering, semi-structured interviews, document analysis and a BMC workshop were all used to provide an in-depth and robust model.

It should be noted that as a largely qualitative research process, the triangulation in this thesis leans more towards corroboration of findings as opposed to confirmation.

3.7 Ethical considerations

The consideration of ethics was at the forefront of this research and was undertaken in a professional manner by the researcher such that ethical concerns were always considered and all data and participants were treated with integrity.

According to Miller and Brewer (2003: 95) “ethical responsibility is essential” for academic research. It constitutes the design of a given study, including “how participants are recruited, to how they are treated through the course of these procedures, and finally to the consequences of their participation” (ibid:95). In terms of this thesis, these considerations have particular relevance in the pre-engagement, business model canvas, and carbon quantification phases of the research. These phases saw the researcher work closely with a number of individuals at the host organisation through focus group and interview settings through which the researcher had ‘freedom within the interaction for exchanging information and interpretations’ (Easterby-Smith *et al.*, 2002: 95). Accordingly, the researcher ensured that participants were engaged with ahead of time before any engagement activity was undertaken, to ensure that they were aware of the reasons for it taking place. Additionally they were informed as to the exact nature of each engagement. For example, prior to the business model canvas workshop taking place, the researcher sent invited individuals an email detailing the reason for the workshop taking place, and information as to what to expect from the process, including a briefing document on what the business model canvas is. This was followed with a presentation at the start of the workshop itself to reiterate this information.

Risk assessment and ethics approval were undertaken by the researcher in 2012 at the onset of the research project and identified that none of the research participants (nor the researcher) would be vulnerable at any point in the research process, to any mental or physical danger. Likewise, at an early stage in the research process the host organisation (WDFG) gave its explicit consent for the research to take place.

3.8 Summary

This chapter has described the selection and overall approach to this research. It takes a multi-method approach and uses a case study methodology that will be analysed using Boardman, Shapiro, and Vining (2004) Comprehensive Strategic Analysis Framework. The researcher believes that this will result in data this is robustly collected, ethically sound, and will generate theory that has value academically, and practically for the aviation sector. The following chapter describes how the first phase of the research, in which the researcher looked to build a relationship with WDFG and collect initial data regarding the company and its operations, was conducted.

4. Research Phase 1; understanding the organisation

4.1 Introduction

Establishing a strong working relationship with the host participant is a vital stage in organisational research, doing so ensuring that the research has rigour, relevance and has utility for the firm in question (Neyland, 2008). Accordingly, it was determined that a period of early engagement activities with WDFG stakeholders would be of vital importance – as well as having the ability to provide the researcher with some initial background information regarding the company. This chapter presents the engagement exercises conducted to achieve such aspirations, and details feedback provided from the organisation regarding the success of the engagement methods adopted. Figure 4-1 illustrates where this chapter fits within the research and analysis phases of this thesis.

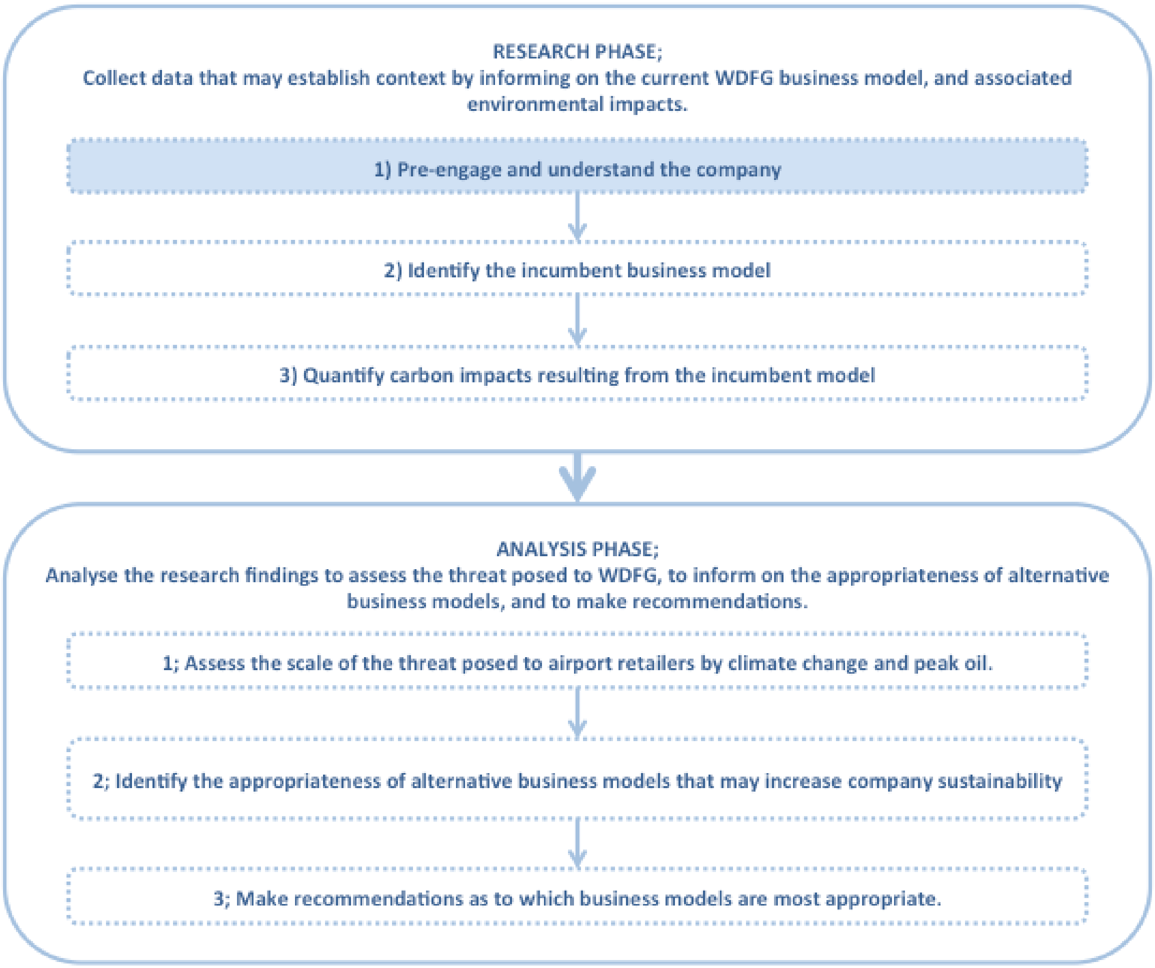


Figure 4-1; Overarching research and analysis phases of this research. The focal phase of this chapter is highlighted in blue.

4.2 WDFG and the researcher; establishing a relationship

4.2.1 The importance of trust and 'buy-in'

Establishing trust with the host firm is an integral but complex part of organisational research. Neyland (2008) defines such activities as being "those close relations established between the ethnographer and research subjects which lead to a mutual exchange of relevant information" (ibid:16). This process can take a great deal of time and energy on the part of the researcher, and usually much more than anticipated at the onset of a research project (Brewerton & Millward, 2001). Additionally, engagement and trust building activities can help to establish 'buy-in' and commitment from the organisation, towards the research project (Brewerton & Millward, 2001), although this trust must be maintained throughout the entirety of the process to ensure that the developed relationships do not deteriorate. Additionally they should include interactions at different management levels within the organisation, particularly at higher levels, as senior management may have the power to restrict the research (Brewerton & Millward, 2001), or indeed to promote buy-in at lower levels. To this aim, the most important personal relationship established through the research was with the Head of Business Relations & External Affairs Director and The Group Brand Manager. These individuals were the internal liaisons for the research project and were actively engaged in its delivery throughout. As such, it was important to demonstrate that the research was being conducted in a timely, responsible and robust manner. Accordingly, it was determined that engaging with WDFG, before main research phases took place, would be an essential determinant in the success of this project and that engagement should occur on a regular basis, rather than as a one-off engagement exercise. This chapter describes the engagement process that took place and that facilitated an effective and open dialogue between the researcher and the host organisation.

4.2.2 Engagement activity; newsletters and regular communication

In order to establish open and regular communication channels with WDFG, the researcher sent bi-monthly newsletters to the Group Brand Manager for further dissemination in the organisation, i.e. to the Head of Business Relations & External Affairs Director or other senior figures. These newsletters consisted of two primary sections:

- An update on the research, including any progress made, obstacles encountered or wider achievements of the researcher; and,
- Information regarding the research themes that were deemed to be of interest to the organisation and that had relevance to the research project. Typically, such items would include summaries of papers published by the research community on issues surrounding sustainability, and corporate reports on sustainability.

An example of a typical newsletter is provided in Figure 4-2 below.

From: Graeme Heyes [mailto:G.Heyes@mmu.ac.uk]
Sent: 05 April 2013 11:20
To: Finn Lawrence; Andy Smith; Sarah Branquinho
Cc: Paul Hooper; Callum Thomas; Cathy Urquhart
Subject: PhD Newsletter Update

Hi all,

Please find below the latest update on my PhD, and news from the wider area of sustainability and retail.

PhD Update

My first journal paper has been submitted for publication in the Journal of Social Business. This is a 'special issue' journal on sustainability and business, that has been put forward by the universities Sustainable and Ethical Enterprise Group, of which I am a member. I will forward a copy of this once it has passed final peer review.

My literature Review is almost finished and I am currently working on a number of summary documents to be disseminated around the company as deemed appropriate. This will leave me in a position to concentrate fully on research for the remaining two years of the PhD and I hope to start producing valuable data in the coming months.

Research, News and Comment

A recent PwC global report found that 53% of CEOs - a 7% increase on last year's results – said the concern about energy and raw material costs as a threat to their business growth prospects.

"Pay what you weigh" - Samoan Airlines become the worlds first airline to charge passengers based on their total weight (i.e. body weight + luggage). If this becomes commonplace could duty free product weight eventually become a concern for passengers?

Virgin Atlantic begin rating all their food suppliers through a sustainability rating programme, to ensure passenger meals are sustainably sourced.

A study finds technology and biofuels will not be enough to meet aviation carbon targets without emissions trading.

Government promises Climate Levy tax breaks for energy efficient firms.

The World Resources Institute has issued a report on the alignment between profitability and environmental sustainability. Its key findings were that companies should;

- Set goals that **integrate environmental considerations** into core business decision-making
- Implement internal mechanisms that **ensure environmental sustainability is valued**
- Vest the chief sustainability officer with greater **authority over capital budget** decisions **and engage the sustainability team early** in project planning
- **Establish and manage metrics** that comprehensively indicate risks and opportunities across the corporate value chain

Another high street retailer (H&M) launches a sustainable fashion line.

Award winning climate change myth quashing blog Skeptical Science debunks Daily Mail article that promoted climate change as a myth through the use established of empirical facts. This demonstrates the difficulty for climatologists with limited potential for media exposure, who must comply with strict methods of scientific vigour, whilst journalists are able to directly influence public perceptions of climate change using any evidence, with no comment on its legitimacy. This is one of the leading sources of confusion regarding climate change in society.

Thanks,

Graeme Heyes

Figure 4-2; example of email newsletter disseminated to key research stakeholders at WDFG.

Newsletters were designed with the reader in mind by being composed in a language and style that the lay businessperson could understand. Doing so would also help the reader to associate with the content and not become disenfranchised from the research due to the use of terminology they may not have understood (but that may be commonly found in academic writing). Up to date and relevant information was obtained by spending time each day during the engagement period looking for information online, powered by three primary tools:

- ***RSS feeds***[38]; using the application 'Feedly' that would deliver pertinent news articles from a number of subscribed news and research sources.
- ***Twitter***; using the 'Tweetdeck' web application, a number of 'lists' and keyword searches were used to give access to many hundreds of tweets per day regarding issues such as sustainability, aviation, or business model innovation.
- ***Email subscriptions and alerts;*** saved searches and email alerts were set up at ScienceDirect.com, to provide weekly emails containing the latest published materials in pertinent research fields.

Supplementary to these newsletters, a number of regular telephone meetings with the Group Brand Manager took place to ensure that the research was on track, and that WDFG were kept abreast of progress made, and actions required on its part. Such regular communication would ensure that commitment and interest in the project would be maintained (Brewerton & Millward, 2001).

4.2.3 Engagement activity; briefing documents

Newsletters, phone calls and meetings acted as a regular means of communication, however engagement was enhanced through specific communication on the issues central to the research project. Doing so helped engage with the organisation on sustainability issues, whilst also creating high quality documents that would purvey a sense of professionalism and trust in the researcher's abilities.

Several 'briefing documents' on key issues were also prepared for wider dissemination to the organisation. As with the newsletters, these documents were

[38] Rich Site Summary; a popular way of subscribing to frequently published information, typically blog entries, news headlines, audio, video.

designed to be relevant to the business community, succinct, readable, and understandable for recipients, whilst also being clear and simple in design to demonstrate a sense of professionalism. The content of each document was determined by the perceived relevance to the research project, and by their ability to inform the company on the issues surrounding Sustainable Development issues. The resulting briefs were completed as each theme was identified and investigated through literature review. Taken as a whole, these documents can be viewed as executive summaries of the Literature Review; designed for a corporate, rather than academic audience, but having academic importance in terms of their ability to act as an engagement and educational tool. An example of such a briefing document is provided in Figure 4-3, whilst a complete list of the briefs created during the project is provided in Table 4-1.

Graeme Heyes
Manchester Metropolitan University

MYTH-BUSTING CLIMATE CHANGE

WORLDDUTY FREEGROUP

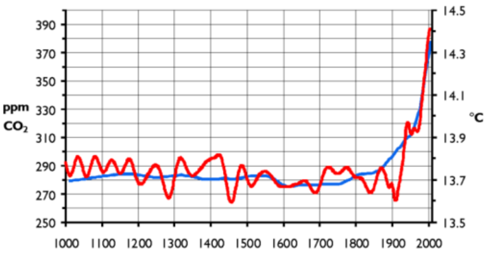
Manchester Metropolitan University

There are many myths surrounding climate change that have led to doubt in the minds of many regarding the likelihood and potential extent of the issue. This document debunks some of the more popular myths, based on proven and reliable evidence from the scientific community.

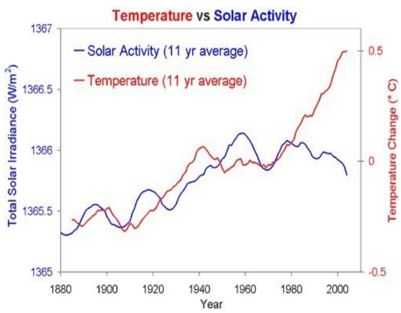
Myth #1; How can the world be heating up when it's so cold?
'Weather' is used to describe localised, short-term events, and are subject to much variability. 'Climate Change', however refers to changes in the **long-term global average** temperature of the planet. To find climate trends scientists look at how weather is changing over a long time span. High and low temperature data from recent decades shows that record highs occur nearly twice as often as record lows, as well as observed increase in extreme weather events such as flooding, drought and hurricanes.

Myth #2; There is no Scientific consensus
In the 20 years between 1991-2011 97.1% of peer reviewed scientific papers on climate change took the position that **climate change is occurring as a result of human influence**. Indeed, between 1993-2003 not a single peer-reviewed academic paper on the subject of 'global climate change', rejected this consensus opinion.

Myth #3; It's not us, it's the Sun
The Earth's temperature is influenced by a number of factors, however since the industrial revolution, **temperature has risen faster than it has done in the previous 10,000 years**. This directly correlates to human carbon dioxide output (a Greenhouse Gas).



This is not due to The Sun (which has actually had a slight cooling effect in recent decades).



Myth #4; I love the summer! Bring on Global Warming!
The negative impacts of global warming for agriculture, health and the environment **far outweigh any positives**. The consequences become increasingly bad after each additional degree of warming, with the consequences of 2°C being quite damaging and the consequences of 4°C being **potentially catastrophic.** Climate Change is often cited as one of the **greatest threats to national security.**

Myth #5; Predictions are unreliable
While there are uncertainties with climate models, they can **successfully reproduce past climate** and have made **predictions that have been subsequently confirmed by observations** since 1900 globally. Some of the worlds most powerful computers are dedicated to this task and whilst not always 100% accurate models used by the U.N. all indicate that human induced climate change is a serious threat to society.

Myth #6; It's a scientific conspiracy
This argument that scientists are exaggerating climate change is flawed on a number of grounds. The scientific community is based on the principle of **falsifiability**, i.e. disproving the established view (i.e. that climate change is false). This is the goal of all scientists, yet despite this, no credible evidence has been found. Secondly, all academic research is scrutinised by other researchers through a process of peer review. It would require **collusion of tens of thousands of researchers** for such a conspiracy to succeed.

Myth #7; It is too expensive to tackle climate change.
Whilst tackling climate change does have its costs, it also poses many opportunities in terms of **growth of new sectors, efficiency savings, and meeting the changing demands of customers.** Furthermore, the Stern Review on the Economics of Climate Change, released for the UK Government in 2005 showed that climate inaction is much more expensive than mitigation today. **Put simply, money spent today is money saved tomorrow.**

Myth #8; It's a hopeless endeavour. Why even bother?
There are plenty of examples of individuals, businesses and nations achieving huge carbon and cost savings through often-simple initiatives. If a concerted global effort is made it is quite possible that we can continue our current quality of life, and bring the world out of poverty, whilst reducing the Earth's carbon output. The potential benefits of action are significant, whilst the costs of inaction could prove catastrophic.

WOULD YOU LIKE TO KNOW MORE?
All of the information in this document is sourced from peer reviewed academic literature. If you would like to see these, or if you have any questions about this document, or regarding climate change in general please feel free to contact Graeme Heyes at **g.heyes@mmu.ac.uk**

Figure 4-3; 'Myth-busting Climate Change'. An example of a briefing document produced by the researcher.

Table 4-1; A list of briefing documents provided to WDFG.	
Brief Title	Description
Introduction to the research project.	A general briefing document regarding the research, and the rationale for it taking place. The document also introduced the researcher, the objectives of the research, and how it might benefit the organisation. This was designed to be presented to employees from across WDFG when engaging them with different aspects of the research throughout the project.
Climate Change Basics	An introduction to climate change for the layperson, including a definition of climate change, how we know it is happening, and the threat it poses to society.
'Myth-Busting' Climate Change.	Aware of the disparity between the public perception on climate change, and the understanding of the concept from the public (Cook *et al*. 2013), this brief set out to answer some of the more popular misunderstandings regarding climate change, by presenting the academic facts regarding the issue, but in a clear and concise way. The 'myths' the research looked to dispel were largely influenced by those discussed on (http://www.skepticalscience.com/argument.php) , a website created and maintained by John Cook, the Climate Communication Fellow for the Global Change Institute at the University of Queensland.
A Sustainable Development Primer.	A introductory document regarding the basic concepts of Sustainable Development, providing a definition, and stating how it is a multi-faceted, societal factor which affects the entire planet and has relevance to corporate organisations ????.
Sustainability and Aviation.	Designed to introduce the broader challenges the aviation sector faces as a result of Sustainable Development issues, putting into context the impacts the industry has on the environment , and how these impacts in turn may impact the sector.
Top Environmental Questions Likely to be Posed.	This document, that was added to throughout the research process, was designed to make WDFG management aware of the type of questions that could be asked of them in the future, should the issue of climate change and airport retail receive greater attention. It consisted of a list of questions that could be difficult to answer at the start of the research, but to which answers would be provided over time.
Examples of 'Radical' Innovation.	This document was created to demonstrate how radical change, whilst difficult, and potentially risky, can deliver huge benefits to an organisation, typically through 'Blue Ocean' thinking (in which innovators are encouraged to look beyond current business markets, and to identify new markets with high potential – see Osterwalder and Pigneir, 2010). The potential benefits of such radical change meaning that whilst not always necessary, WDFG should be mindful of the potential benefits of such scales of change.
Sustainable Innovation	Here, the researcher aimed to illustrate the potential power of sustainable innovation to drive economic growth. The Kondratiev Cycles discussed in Section 2.4 of this thesis were introduced, along with the advantages of being an early adopter, and dangers of being a 'laggard'.
Sustainable Businesses.	This document acted as a primer on the concept of the sustainable business, and how it can act as a catalyst towards improved performance, whilst safeguarding against externalities. It included examples of some leading sustainability centric business models.
Sustainability and Retail	Similar to the Sustainable Business paper, this document focused more on retail, and sustainable retailing business models.
Sustainability and Risk.	This brief provided detailed examples of companies that have suffered as a result of not embracing sustainability, with the aim of further demonstrating the potential risks of non-action regards the challenge of Sustainable Development, and climate change.

4.3 Initial data collection

Additional to the engagement processes described above, this opportunity was also used to gain an initial understanding of the organisation. Doing so would act as support further engagement and help build a strong working relationship, but more importantly it would give a deeper understanding of the WDFG business, the industry in which it operates, and the wider issues surrounding each. Seeking such information direct from the organisation would help provide an understanding of how it views its own business, and potentially provide access to data and information not available in the public domain.

This was achieved through some early informal interviews with senior decision makers in the organisation with The Group Brand Manager and the Head of Business Relations & External Affairs Director, through general 'catch-up' meetings throughout the early stages of the research, and by reviewing a number of documents about the organisation, as listed in Table 4-2.

Table 4-2; Descriptions of the sources of data that enabled the research to develop an initial understanding of the current WDFG business.

Data Source	Description
Literature Review	Wide ranging sources of information regarding the airport retail sector, as provided in Chapter 2 of this thesis.
Verdict Global Airport Retailing Report (Years 2012-2014) (Verdict, 2012;2013;2014)	High level industry reports regarding the airport retail industry as a whole, and specific airport retailers such as WDFG and its competitors
The Moodie Report	A daily newsletter specific to issues surrounding the airport retail sector (see http://www.moodiereport.com/)
WDFG Environment Policy (WDFG, 2013)	A WDFG produced document detailing its policy towards environmental issues to establish the principles towards "managing and developing the business in sustainable manner".
WDFG Sustainability Report (WDFG, 2013)	A WDFG document summarising what has been accomplished in sustainability terms and future commitments.
WDFG Suppliers Policy (WDFG, 2013)	An internal policy document that sets out the guiding principles governing relations with WDFG's suppliers.
Autogrill Group Sustainability Report (Autogrill, 2012)	A technical document created prior to the companies rebranding from Autogrill to WDFG that summarises what sustainability accomplishments and future commitments to this issue.
Multiple informal conversations and discussions with WDFG employees, conducted as semi-structure interviews.	Discussions that took place with Finn Lawrence at WDFG throughout the research process, both in a formal semi-structured interview settings, and through informal conversations that took place over the initial months of engagement in the company.

The information obtained helped to provide an initial grounding to the research project, which proved useful in the phases that followed. This was particularly true for Research Phase 2 where the Business Model Canvas was applied to the organisation. The information uncovered at this early stage of the research helped to ensure that the researcher had an underpinning awareness of the organisation, the activities it conducts, and of the broader airport retail industry, prior to the BMC workshop taking place in the following phase. Doing so would help with the facilitation of the BMC workshop by ensuring the researcher was fully informed about the research setting prior to the workshop commencing. Additionally, this information proved essential in satisfying the requirements of Situation Analysis element of the Comprehensive Strategic Analysis framework, described in Section 7.2.

4.3.1 World Duty Free Group; introduction to the company.

4.3.1.1 The airport retail sector; performance and future outlook.

Airport retailing, as defined in Literature Review, generates large revenues. Table 4-3 details some key financial data for the sector. The sector has been continuously growing for many years, with Verdict (2014) anticipating that growth will accelerate, peaking at 11% in 2019, with an accompanying global turnover of US$59nb in product sales and a profit of approximately US$5,176m[39], due to increased passenger numbers and a growing global economy. The majority of this growth is expected to happen in the Asia-Pacific region (16.1%), with the European market expected to grow by 4.6% per annum. As illustrated in Figure 4-4 below, the beauty category of products is currently the most profitable for airport retailers, representing 40% of industry revenues, with alcohol second at 17%. By 2019 these categories are expected to grow by 4.4% and 4.6% respectively.

[39] Based on an EBITDA (Earnings before interest, taxes, depreciation and amortization) of 14% (based on the average of EBITDA margins for Dufry and World Duty Free Group).

Table 4-3; Key financial figures for the Airport Retail Sector (Verdict, 2014).			
	Turnover (US$m)	Passengers (m)	Average Spend per Passenger (US$m)
Asia Pacific	14,673	1,885	7.78
Americas	7,764	1,685	4.61
Europe	11,371	2,104	5.40
Middle East	3,033	466	6.51
Global Turnover	36,840	6,139	6.00

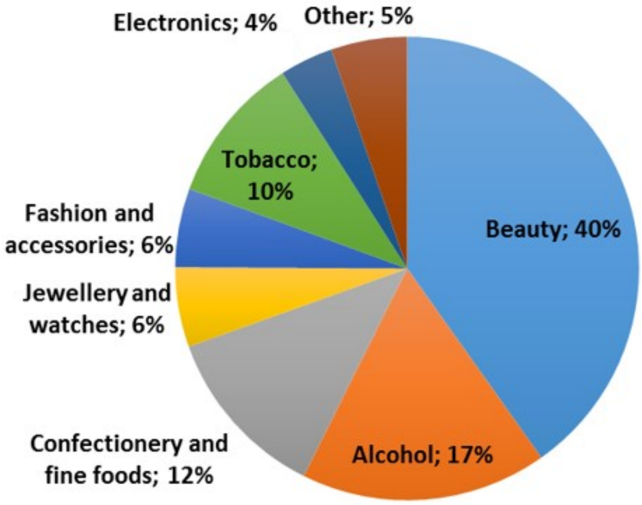


Figure 4-4; Global airport retail product categories by percentage of revenues (Verdict, 2014)

There are a large number of retailers operating in the sector, typically focusing on certain geographical regions, Table 4-4 illustrates who the market leaders in the sector are, demonstrating that as of 2014, WDFG were the second largest duty and tax free retailer globally.

A report by Verdict (2014) on the global airport retailing sector identified a number of factors influencing the future performance of the sector that will play a key role in this, as shown in Figure 4-5.

Table 4-4; illustrating the percentage of market share by revenue of the top 10 airport retailer brands	
Retailer	Percentage Market Share
Aer Rianta	4.6%
DFS Group	4.4%
Dubai Duty Free	5.5%
Dufry	9.9%
Gebrüder Heinemann	6.4%
Lotte Duty Free	4.8%
LS Travel Retail	5.5%
Nuance Group	5.2%
Shilla Group	2.7%
WDFG	7.8%
Total	56.8%

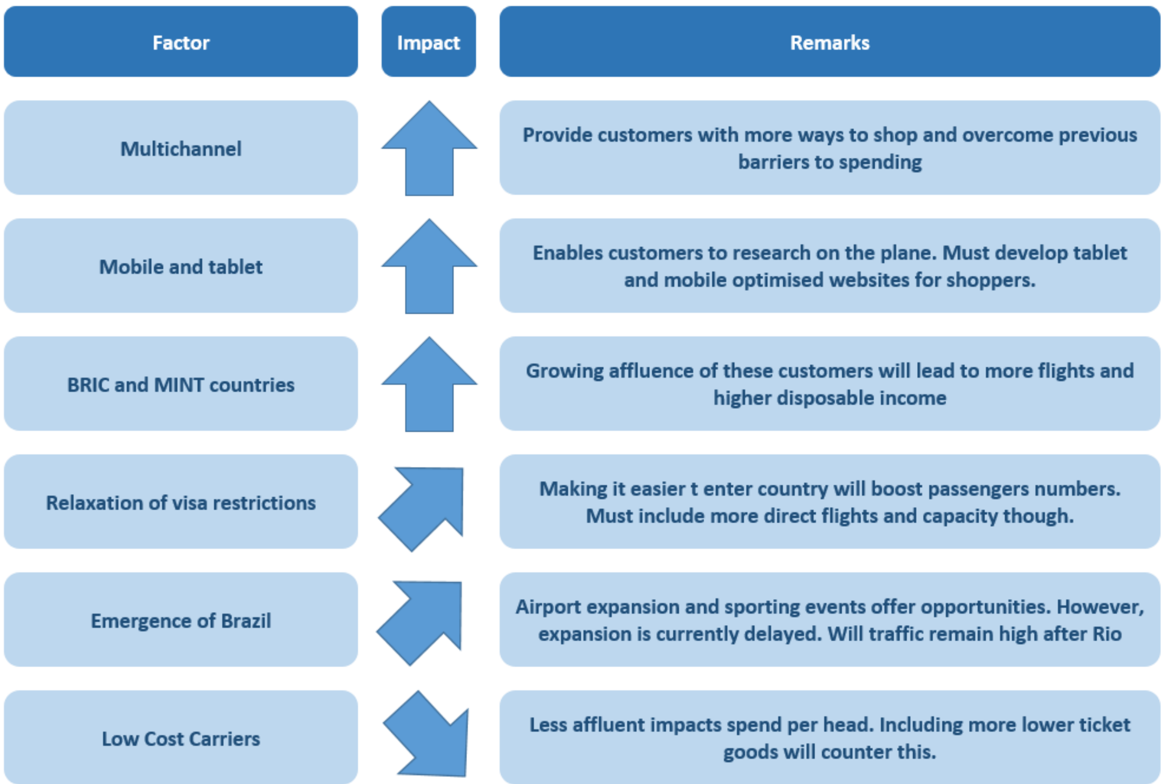


Figure 4-5; factors influencing the future performance of the airport retail sector (Verdict, 2014)

Of particular relevance to the WDFG business model and potential innovations thereof, is the suggestion that the sector moves towards multi-channel means of retailing – i.e. using BMC terminology, providing additional channels and customer relationships to the existing retail offer of purchasing and taking ownership of items in physical stores. The report notes that this is increasingly the case with high-street retailers, that offer customers home delivery, and click and collect (purchasing on-line and collecting in store) and that airport retailers should look to follow suit. Multichannel offers provide customers with more convenient ways to shop that can boost average spend per customer, as illustrated in Figure 4-6 below. There is great potential here for airport retailers as they are often limited in the amount of time they have to shop in the airport. By empowering shoppers with enhanced on-line offers, customers have more time to browse, whilst the ability to reserve items for in-store collection, or home delivery ensures that they always receive the products they want, whilst collection on arrival enables passengers to overcome baggage restrictions.

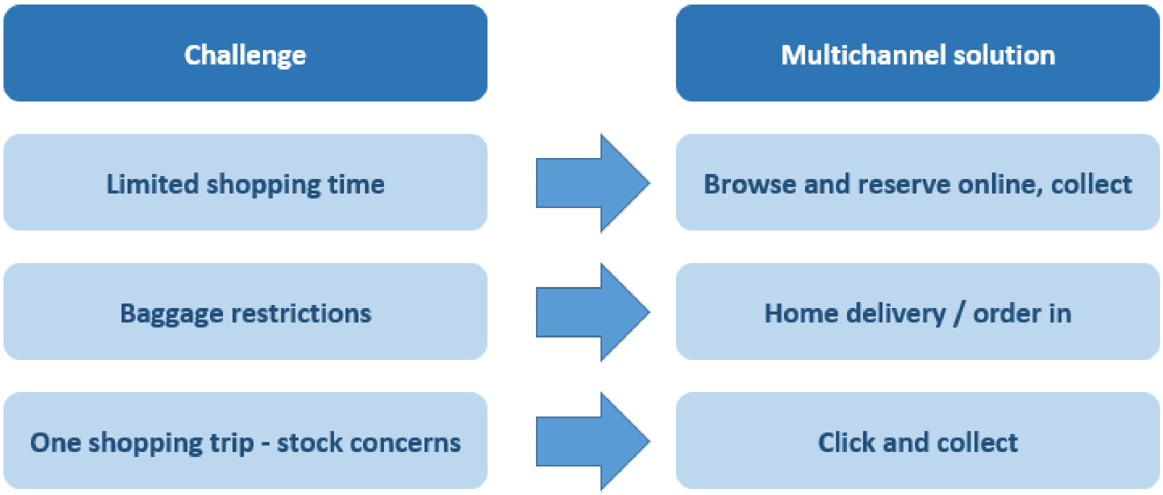


Figure 4-6; how multi-channel customer channels may overcome airport retailer challenges (Verdict, 2014).

Examples of such initiatives are already being explored by a number of airport retailers. Dufry Duty Free[40] for example provide a reservations website to their Brazilian customers before travelling. Likewise, a number of retailers including WDFG and Nuance[41], are offering passengers the ability to collect on arrival at certain airports. Non Duty-Free retailers are also referenced in the report as implementing multi-channel retailing, with Boots trialling an airside collection service at London Gatwick which enables customers to purchase items before flying and collecting them on arrival. Similarly through literature review, UK supermarket Tesco were identified as trialling an airport offer[42], whereby passengers can order items in the airport using touch screen kiosks in order to buy groceries that would be delivered when passengers return from their trip. This

[40] http://www.dufry.com/
[41] http://www.thenuancegroup.com/
[42] http://www.bbc.co.uk/news/technology-19148154

option takes up little floor space in the airport , provides customers with a convenient service, and represents an example of external new entrants to the sector potentially looking to move into this lucrative environment.

Whilst the general outlook for the sector is good, there is some enhanced risk for the sector through the growth of the LCC market. These carriers represent 38% of air traffic in Europe – the location of most WDFG stores. According to Verdict (2014) LCC passengers have a lower propensity to spend than other forms of travellers, and as LCCs are typically short haul, these passengers are often not eligible for duty free, within the EU. This suggests that whilst the growth of LCC's helped to increase the importance of concessions for airport operators, their continued growth may eventually lead to problems for the retail sector down the line – particularly if airport operators are able to find identify new revenue streams from other non-aeronautical sources. Notably the Verdict (2014) report contains no reference to environmental, peak oil or other Sustainable Development orientated issues.

4.3.1.2 Company background and current Strategy.

In 2014 WDFG had a turnover of €2,406m, representing growth of 15.8% compared to the previous year's accounts. In the UK growth was 8.4% due to higher airport traffic and spend per passenger, and the abolishment of the one bag rule[43]. Founded in 1955 as 'Alpha Duty Free', WDFG is today one of the world's leading airport retailers, with headquarters in Madrid and London. WDFG since went through a number of mergers before demerging from parent company Autogrill Group to trade on the Italian stock market in 2013 as World Duty Free S.p.A. that saw the company become 50.1% owned by the Italian Benetton family. The remaining 49.9% of shares in the company are in the hands of public investors.

Today the group operates over 500 airport shops in over 100 airports, and in 20 counties - most significantly in the UK and Spain. Some 77% of its sales are generated in Europe, where it is the market leader - with 47% of these sales coming from the UK. According to the company's 2014 Annual Report (WDFG, 2014) the business is also looking to expand into the United States market. Of

[43] A measure introduced by some Low Cost Carriers to reduce the amount of baggage (and weight) passengers take onto aircraft (see BBC, 2007).

these markets, the global airport retail market is showing the following levels of expansion/decline. The company documentation shows no evidence of plans for diversification from this central activity of product sale at airports, other than ancillary revenues that arise from this central activity. As such it's long term success is heavily reliant on the continued performance in this activity.

To satisfy the diverse range of its many customers (potentially any airport user) the Company sell a wide range of products comprising a number of categories, by working with over 1,000 brand partners (suppliers), managing a total of 120,000 square metres of shopping space globally. As illustrated in Table 4-5, items are typically luxurious in nature, that is to say that as well as often being expensive, specialist and high end products. Albeit the product ranges sold also include a host of items typically available on the high-street and in supermarkets, for example wines, spirits and tobacco.

43% of WDFG sales originate from the beauty shopping category, followed by drinks (18%) and tobacco (12%). 55% of sales are made as duty-free purchases.

Table 4-5; WDFG Retail Brands 2014 (Source; Verdict, 2014).		
Store Classification	Retail Brand	Retail concept
Duty free	Alpha airport shopping	Over 17,000 product categories sold, including alcohol, confectionery, cosmetics, fragrance, fashion accessories, sunglasses and travel essentials
		Located at Humberside Airport
	Biza	Delivers a department store experience by bringing a portfolio of brands together
		Located at East Midlands, Manchester (Terminal 1 and 2) and Newcastle airports
	The Express Shop	Located close to boarding gates
	The Shop	Alcohol, cosmetics and perfume, food and tobacco
	World Duty Free	Over 17,000 product categories sold, including alcohol, confectionery, cosmetics, fragrance, fashion accessories, sunglasses and travel essentials
		Present at Aberdeen, Belfast City, Birmingham, Bournemouth, Bristol, Edinburgh, Exeter, Gatwick, Glasgow, Heathrow, Jersey, Liverpool, Stansted, Southampton
		Generic brand used across other international locations, with regional name applied to fascia (e.g. Barcelona Duty Free)
Specialist stores	Beauty Studio	Premium Skincare, located in Heathrow T4
	Cigar House	Present at Heathrow Airport (T3 and 5)
	Cocoon	Skincare store present at Heathrow T1 and Manchester Airport
	La Cava del Cigarro	Cigars. Present at Madrid Barajas
	Collection	Designer branded accessories. Bristol Airport and Heathrow T1 and T2
	La Cava del Vino (Chile)	Wine and Chilean food
	Perfume Gallery	Perfume store located at Heathrow T1
	Simply Chocolate	Present at Heathrow airport
	Sunglasses	30 different labels of designer sunglasses. Present at Edinburgh Airport and Gatwick South
	Watch & See	Luxury sunglasses, watches and accessories
	World of Whiskies	Sells over 350 whiskies. Edinburgh, Heathrow T1 and T5, Stansted and Gatwick North and South
Souvenir shops	Glorious Britain	Sells British souvenir goods at Gatwick North, Heathrow (T1, T2, T3, T4 and T5) and Stansted
	Thinking	Specialist souvenirs of the country or region visited. Locations include Edinburgh, as well as others in Spain and Canada
	Les Boutiques	Haute couture clothing, leather goods, luxury jewellery and watches

WDFG strategy focuses on three main areas (WDFG, 2014a);

- The Travel Retail Industry; the company are looking to deliver sustained growth through the travel retail sector, driven by increasing passenger numbers, increasing passenger spend and the emergence of new duty free markets. The entire business is focused on serving this market, with no signs of diversification into other industries.
- WDFG unique portfolio; they have a stronghold position in three key markets – the UK, Spain and the USA. The company also has a 96% contract retention rate (9 years on average) with 53% over 10 years, and less than 5% less than 5 years in length. Focusing in these key areas has

seen the company heavily reliant upon them, with the UK and Spain representing 74% of total WDFG turnover.

- Partnerships; WDFG maintain close working relationships with airports and brand partners to create exciting and innovative environments, and to display brands. This commitment to working with airports is evidence that central to the success of the business is gaining the right to operate within the airport setting. In this way it can be seen how the Company must compete at two levels; winning bids to operate at the airport, and attracting passengers to buy items at the airports in which they are based. Thus it is vitally important that the Company must respond to the specific concerns and requirements of each airport operator, whether they be based on economic, logistical, environmental issues, or any combination these or other factors. Additionally, many product brands stocked by WDFG have strict terms on how their products may be displayed in store – often deploying their own consultant to determine how products will be displayed – including for example levels of lighting. To maintain positive relationships with these brands, WDFG must attempt to meet their requirements wherever possible.

In order to deliver on this strategy, the WDFG business model is focused around five main components on which they compete (WDFG, 2014b):

- Airport partnerships; including design innovation and understanding airport partner needs at each location.
- Stunning stores; both in terms of design and customer service.
- Brand expertise; including involving brands at a strategic level when planning floor space, merchandising and promotions
- Customer focus; dedication to meeting customer needs through shopping solutions and product choices.
- Skilled People; they employee a large, diverse, and highly skilled workforce.

4.3.1.3 WDFG and sustainability

As stated in the Literature Review airport retail emissions from companies such as WDFG is similar in source as other retailers, but are higher due to the characteristics of the sector. According to the WDFG 2014 Annual Sustainability Report, the primary sources of such emissions are electricity consumption at it stores, offices and warehouses, and diesel usage by the Company's logistics fleet. Additionally waste, water and business travel have an impact in the Company's emissions. The 2014 Sustainability Report states that carbon emissions from WDFG's UK operations total 6,767 kg CO_2 per year[44].

WDFG have looked to reduce the carbon emissions that result from its business through a number of initiatives, such as those listed in Table 4-6.

Table 4-6; Examples of WDFG initiatives to reduce carbon emissions (WDFG, 2014a).

Emissions Source	Reduction Initiatives
Energy Usage	Savings through store re-design with a focus on substituting traditional lighting for highly efficient LED and low energy bulbs. Additionally they have installed 'A' rated air conditioners and fridges, and integrated energy saving shut down procedures when stores are closed. The company has received acknowledgements for its energy saving initiatives, The company won the Champion of Champions accolade at the Green Apple awards, 2012 for initiatives at Birmingham airport - that have since been implemented at other sites.
Waste	Majority of waste from cardboard packaging. Efforts to reduce this has seen emissions from waste fall despite an increase in sales. All WDFG waste is recycled. Non-recyclable waste in the UK is converted to energy through incineration.
Business Travel	The company has strived to reduce the impact of staff travel through employee engagement.
Material Use	The company has engaged with customers to reduce bag usage, and has switched to bags made out of recycled materials. They have also reduced office paper usage and the use of pallets and cartons used by its delivery vehicles.
Product distribution	Vehicles are fitted with EURO 5 and 6 engine standards - the highest grades for low carbon emissions on the market. Emissions have also been reduced through optimised transport routes, and backhauling - a process where the company picks up products from suppliers with their post-delivery, to minimise the amount of time its trucks are empty. In 2011 WDFG were awarded with the Supply Chain Team of the Year awards at the Retail Week Supply chain Awards as a result of these initiatives.

Additionally, the WDFG Supplier Policy (WDFG, 2013) states that WDFG expects its suppliers and business partners will comply with the ten principles of the United Nations Global Compact. This includes a requirement for these groups to:

- Support a precautionary approach to environmental challenges.
- Undertake initiatives to promote greater environmental responsibility.
- Encourage the development and diffusion of environmentally friendly technology.

[44] These figures only include electricity consumption of stores and offices and diesel usage by the WDFG logistics fleet.

All the above is illustrative of WDFG already addressing the direct environmental impacts of its operations to some extent, through an a multi-award winning environmental management system. This suggests that the company is keenly aware of the environmental impacts on their business, albeit whether these initiatives have been driven by costs, regulation or other short-term pressures, as opposed to a long term commitment to addressing sustainability issues is not clear.

4.4 Researcher observations

Neyland (2008) defined the building of trust in organisational research as "those close relations established between the ethnographer and research subjects which lead to a mutual exchange of relevant information". The strong working relationship established with WDFG at a very senior management level and, the processes described in this chapter confirm that engagement with WDFG was a success. At the outset, information was shared with WDFG in an engaging, and easy to understand way; at the same time the researcher achieved an initial understanding of the firms operations. This trust was added to throughout the research process, as more information was uncovered and shared between the researcher and firm. By building this relationship, the researcher was encouraged to contact the participants regularly and freely when it was felt necessary to do so (for example asking questions, arranging meetings, requesting data). Furthermore, the researcher always made to feel that their opinion mattered and was of value to the organisation. This can be evidenced by the fact that the research project was widely communicated within the organisation, for example in its 2014 company brochure (WDFG, 2014b) and in its 2014 Annual Report (WDFG, 2014b), of which an excerpt is provided in Figure 28 below.

THE IMPLICATIONS OF CLIMATE CHANGE FOR THE FUTURE OF AIRPORT RETAIL AND THE DUTY FREE SECTOR

IN 2012 WDFG SPONSORED A THREE-YEAR RESEARCH DOCTORATE IN PARTNERSHIP WITH THE MANCHESTER METROPOLITAN UNIVERSITY (MMU).

ALTHOUGH CO_2 EMISSIONS ASSOCIATED WITH AIRPORT RETAIL REPRESENT A SMALL PROPORTION OF THOSE FROM THE WIDER AVIATION INDUSTRY, THE SECTOR NONETHELESS NEEDS TO EVALUATE ITS CLIMATE CHANGE RISKS AND DEVELOP ADAPTATION STRATEGIES.

THIS STUDY AIMS TO INVESTIGATE CO_2 EMISSIONS ARISING DIRECTLY AND INDIRECTLY FROM THE AIRPORT RETAIL AND DUTY FREE SECTORS AND TO CONSIDER ALTERNATIVE LOW CARBON BUSINESS MODELS THAT WOULD BE APPROPRIATE FOR A FUTURE LOW CARBON ECONOMY.

THE OBJECTIVE IS TO EXAMINE THE BUSINESS MODEL AND — WHERE APPROPRIATE — SEEK SOLUTIONS TO ENABLE THE SECTOR TO ADAPT TO CLIMATE CHANGE SO AS TO MAINTAIN INCOME, EMPLOYMENT, MEET CUSTOMER EXPECTATIONS AND WIDER SOCIETAL CONCERN.

KEY OUTPUTS OF THIS RESEARCH STUDY INCLUDE A NUMBER OF REPORTS WHICH WILL IDENTIFY POTENTIAL NEW OPPORTUNITIES AND ASSIST IN DEVELOPING THE GROUP'S FUTURE SUSTAINABILITY STRATEGY.

THIS WORK IS DUE FOR COMPLETION IN APRIL 2015, AND WILL COMPRISE A KEY DRIVER FOR WDFG'S PROGRESS IN SUSTAINABILITY.

Figure 4-7; demonstrating how the project was communicated to WDFG partners in its Annual Report (WDFG, 2014)

Initial feedback from WDFG regarding the briefing documents and newsletters was positive – as evidenced by proactive engagement with the project by the Group Brand Manager and Head of Business Relations & External Affairs Director. In addition, it is noteworthy that shortly after sending the newsletters, the latter began to proactively send emails to the researcher that they thought of relevance to the research project. This indicates that some level of 'shared learning' was being achieved between the researcher and research participants. The high level of trust developed with the organisation is further evidenced by the fact that the researcher was asked to participate in a commercially confidential exercise testing a competitor's business model. Additionally, the researcher was asked to assist with input to a tender for an operating contract that WDFG were bidding for in the United States, in which input on the potential to carbon offset[45] company emissions was provided. The fact that acquisition of new operating contracts (particularly in the United States) are key objectives for the company, and potentially worth millions in revenue, again demonstrates that trust and a close working relationship had been established with the research participant.

[45] Carbon offsetting is the use of carbon credits to enable businesses to compensate for their emissions, through schemes such as carbon sequestration, or increasingly through schemes designed to help those impacted by climate change meet their carbon reduction goals and support the move to a low carbon economy (Hooper and Preston, 2008)

The briefing documents were particularly well received, with complements made the appropriateness and quality of their presentation by the Group Brand Manager and Head of Business Relations & External Affairs Director. The suite of documents were designed to inform on a wide variety of relevant topics, both technical and socio-political. The Climate Change 'Mythbusting' document for example was designed to debunk some of the more popular myths surrounding climate change that often appear in the media. See for example the excerpt shown in Figure 4-8;

> **Myth #2; There is no Scientific consensus**
> In the 20 years between 1991-2011 97.1% of peer reviewed scientific papers on climate change took the position that **climate change is occurring as a result of human influence**. Indeed, between 1993-2003 not a single peer-reviewed academic paper on the subject of 'global climate change', rejected this consensus opinion.

Figure 4-8; Example of one of the 'busted myths' in the climate change myth-busting brief.

On presentation of this brief, a senior WDFG executive who had yet to be convinced on supporting evidence behind climate change noted that "the case for climate change did not have a consensus" in the scientific community. This was a clear indication that that the pre-existing beliefs of the individual regarding climate change had perhaps been influenced by media outlets or their own internal values and beliefs, rather than by the evidence presented by the scientific community.

4.5 Summary

This chapter described the engagement process by which the researcher engaged with host organisation and key research participants. The following key issues can be noted from that process:

- The researcher was able to build a close working relationship that resulted in a mutual exchange of information, and buy-in to the project from participants. This would prove useful in the latter stages of the research (for example securing senior management level attendance in the Business Model Canvas workshop described in the following chapter).

- Leaflets created and given to staff started some positive dialogues about sustainability.
- The current financial and retail position, and the existing corporate strategy, was analysed in this phase.
- Sustainability initiatives undertaken by the company were identified.
- This engagement phase empowered the researcher to gain valuable background insight to the company and the wider airport retail sector that would prove invaluable throughout the remainder of the research.

The next chapter builds on this initial knowledge gathering by identifying and clarifying the business model used by WDFG, before going on to identify the environmental impacts that result from this model in Chapter 6.

5. Research Phase 2; understanding WDFGs business model: business model canvas findings

This chapter describes Research Phase 2, in which the objective is to understand the incumbent WDFG business model. Doing so will provide the researcher with an in-depth awareness of the organisation, it's characteristics, and the likely sources of carbon emissions that arise from its operations. This was achieved using Osterwalder & Pigneur's (2010) Business Model Canvas (BMC), which is introduced in Section 5.1.1 below. The results of its application in terms of understanding the business model are described in Section 5.2, with observations of the resulting canvas, and a broad analysis provided in Sections 5.3 – 5.6.

5.1.1 The business model canvas

This section describes how the Business Model Canvas workshop was conducted with WDFG, with the aim of understanding the incumbent business model used by the organisation. The results obtained are also presented. The broad concept of the BMC, including its overarching aim, and the elements to which it looks to describe, are detailed in Sections 2.6.3 and 2.6.4.

To accomplish this phase of the research, the researcher followed the guidelines provided by Osterwalder and Pigneur (2010) publication Business Model Generation: A Handbook for Visionaries, Game Changers, and Challengers. According to this guidance, the authors state that an important part of identifying new, and innovative business models is to first understand the incumbent models underpinning the firm being studied. This should ideally take place in a separate workshop from the any innovation activities, in order to provide multiple perspectives on the strengths and weaknesses of the existing business model, independent - as far as possible - of any pre-existing preferences for new models (Osterwalder & Pigneur, 2010).

The existing business model can inform the innovation process by identifying how current business activities lead to profitability in the current market, how successfully, and where the process of profit generation could be improved. This acts as a framework on which modifications to the business model (incremental or radical) can be based. Doing so also helps to ground research participants with the same definition of what the business model as a concept actually is, and provide a shared understanding of the specific model used by the focal organisation (Osterwalder & Pigneur, 2010).

5.1.1.1 Workshop attendance, setting, and attendance

Several different methods were used to clarify the current broad corporate strategy operated by WDFG, including a literature and internet review, and interviews with key members of the company's senior management team (as detailed in Chapter 4). A workshop in which the BMC was used to investigate the current WDFG business model took place on the 11th March 2014 at WDFG UK head office, near to Heathrow Airport. The attendance of participants was agreed in consultation with the key WDFG stakeholder (Finn Lawrence). Eight senior managers from across the organisation were invited to participate, of whom five attended:

- Sarah Branquinho; Business Relations & External Affairs Director
- Gerry McIntyre, Operations Manager
- Joanne Evans, UK Head of Trading
- Des Fischer; Airport Relations and Development Manager
- Ben Deller; Head of UK Retail Marketing & Global Digital
- Finn Lawrence, Group Brand Manager – *Did not attend due to illness*
- Simon Kirwin, Health, Safety, and Environment Manager – *Did not attend due work priorities*
- Sarah Fox, Supply Chain Development Manager – *Did not attend due work priorities*

The fact that the five participants who did attend were all senior members of the UK management team and represented diverse areas of the Company indicates that this was as a good sample of knowledgeable individuals with a broad overview of current WDFG operations who would be able to provide a solid understanding of the current WDFG business model. The BMC methodology (see Osterwalder and Pigneur, 2010:251), points out that innovation may pose a threat to certain parts of the organisation and influence the answers individuals provide. To account for this, all participants were given the time and opportunity to speak and express their views freely, thereby ensuring that all opinions regarding the organisation were effectively communicated. Assembling such a cross-functional team provides the basis of the ideal business model task force (see Osterwalder and Pigneur , 2010, p 251); being able to generate better ideas, and to increase the prospect of the project succeeding.

The researcher feels that the workshop was a great success. It was noted that each participant contributed on a number of occasions during the process, and would often contradict the opinion of others – evidence that views were being expressed clearly. 146. That said, a consensus opinion was obtained regarding the canvas final content - demonstrating that the captured data was indicative of the wider group. A number of participants commented that the session had been "quite therapeutic" and that they were able to "get a lot of their chest", further demonstration of the fact that both they, and the researcher, found the experience a valuable one.

Assembling the appropriate individuals is a critical factor in the BMC process. In this instance, finding appropriate participants faced the challenge of obtaining the time of (busy) senior managers for a two-hour lengthy meeting. The BMC literature states that mapping sessions should involve 'large' groups, however considering the limitations of gaining access to high-level members of the company, and the broad range of expertise and knowledge provided by the participants, the researcher believes that sample size can be viewed as a success.

To help inform participants about the workshop and motivate their engagement, briefing materials created by the researcher were distributed prior to the event by The Group Brand Manager to all invitees. This had the objective of explaining the research, its origins, reasons for taking place, as well as introducing the concept of the BMC itself. This was further established at the start of workshop via a presentation conducted by the researcher, in which the concept of the business model was defined, as well as its importance to organisational performance.

To help facilitate the workshop and to ensure that all participants were aware of what was expected of them, time was also spent explaining the process that was to take place, with the BMC presented and each of the nine BMC elements being introduced and explained. Doing so created a common language for use throughout the canvasing process, helping to describe, design, and analyse the WDFG business model. It would also help to establish the legitimacy (Suchman, 1995) of the process that was about to take place. That is, that the method is academically robust, popular in the business world, and part of a research process internally supported by WDFG executive management. The attendance of the

Business Relations & External Affairs Director, with whom the researcher had established a strong working relationship over the preceding months, was particularly important in supporting this objective. Her attendance, as well as the relationship established with the company as a whole in the engagement phase of the research, meant that the workshop was able to go ahead without the attendance of the researcher's primary contact the Group Brand Manager, who was unable to attend due to illness.

Following this presentation, the mapping phase of the workshop began, working through each of the elements in turn using an A0 sized version of the canvas obtained from www.businessmodelgeneration.com. Each participant was provided with pens and post-it notes to complete the canvas as each element was discussed. The researcher facilitated the event by working through each canvas element sequentially, asking probing questions designed to elicit responses from participants that might result in useful data being generated (in the form of completed post-it notes). The workshop lasted for two hours, which proved ample time to collect the necessary data. The responses collected were detailed, accurate and no key data was excluded (an opinion also held by the Group Brand Manager upon review of the canvas).

5.2 Findings and observations

5.2.1 Overview of the identified business model

The Business Model Canvas produced in the workshop is presented in Figure 5-1. It is evident that the business model is indicative of the 'master concessionaire'[46] model of airport retailing in that WDFG have a clearly defined remit to operate as the service provider of duty and tax-free retailing for the airport operator. Based on the BMC workshop and the resulting canvas, it is possible to outline the internal activity chain (See Porter, 1986) of the WDFG business, as illustrated in Figure 5-2 below, following the same framework as used by Freathy and O'Connell (1998) to describe typologies of airport retail, as introduced in Section 2.8 of the literature review.

46 See Section 2.8

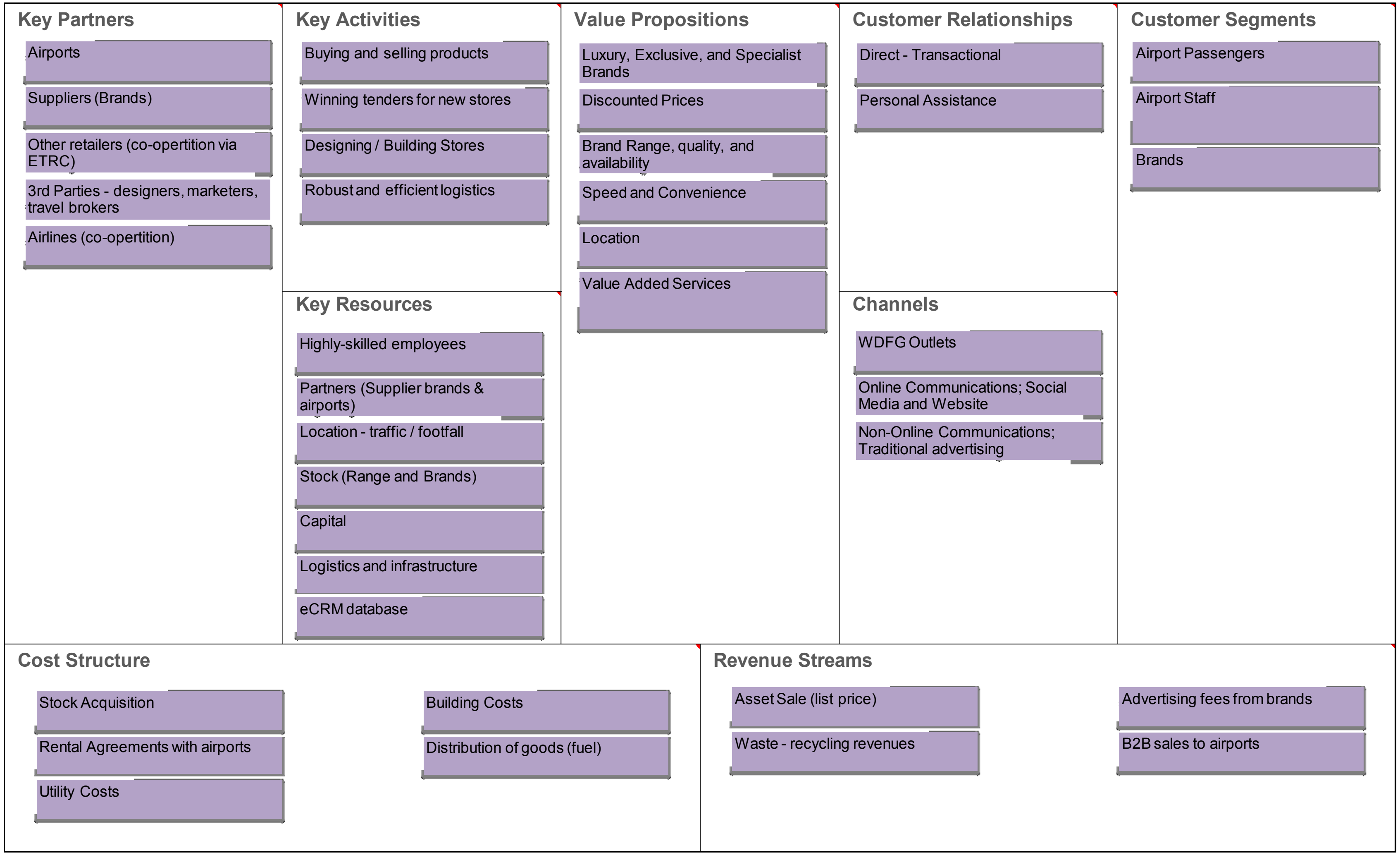


Figure 5-1; The WDFG Business Model Canvas

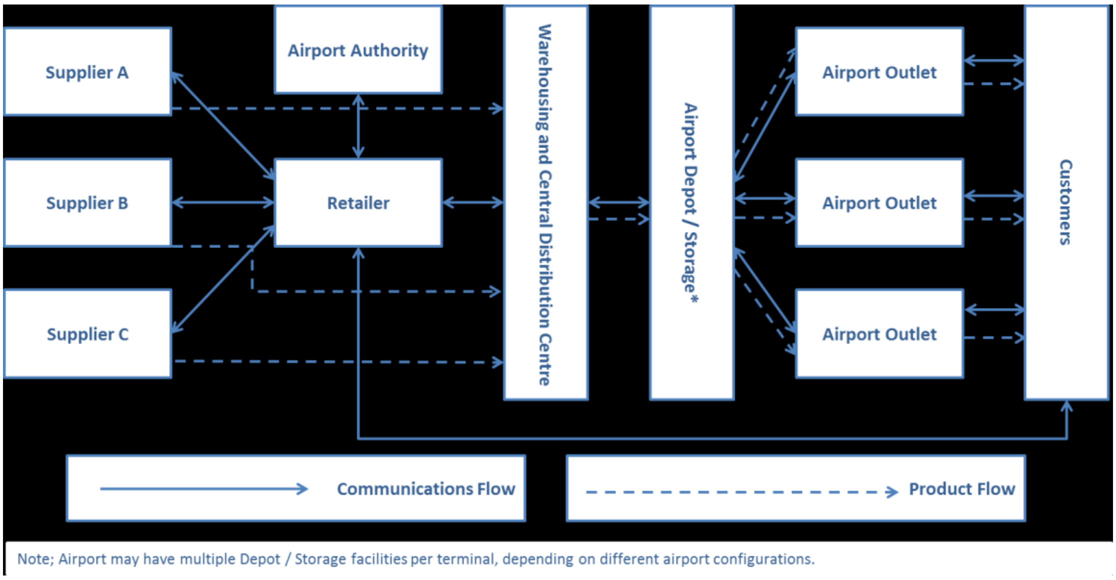


Figure 5-2; The WDFG 'Internal activity and communication chain'

As Figure 5-2 above shows, the process of selling products at Manchester Airport to passengers is relatively linear. Products are delivered by WDFG suppliers, to the Company's bonded warehouses and Central Distribution Centre (CDC), before being sent to smaller, more localised bonded warehouses located across the United Kingdom. From here, products are sent to airports as required, where they are further distributed to individual outlets, and ultimately to airport passengers. Deliveries are made once per day by a large articulated lorry, before being sorted at the airport in a small sorting facility, and subsequently being redistributed to each individual terminal by a small van (Ford Transit). At this point, items are either taken directly to the shop floor where they are placed on shelves, or they are kept in secure storage facilities near each outlet. Replenishment occurs at night when the airport is closed, to ensure that disruption posed to passengers is kept to a minimum. WDFG operate a duty free outlet in each of the three terminals at MAN. Each outlet differs in size; 23567 Square feet (Terminal 1), 18447 Square feet (Terminal 2), and 6077 Square feet (Terminal 3).Typically however, each outlet carries the same broad characteristics. They are internal of the airport structure with no natural lighting, and are open plan to the rest of the airport – meaning that heating and cooling systems work at odds to the airports own larger heating systems. Terminal 2 requires passengers pass through the retail outlet in order to reach the terminal gates (so as to increase the likelihood of impulse purchasing).

This represents a vertical value chain, defined by Besanko *et al.,* (2007) as the process that begins with the acquisition of raw materials and ends with the distribution and sale of finished goods and services – albeit the WDFG model does not go as far back as to include raw materials.

Communication is a key component of this entire network in that it empowers the outlets to disseminate what needs stocking from the floor, to their central storage facility. Communications with suppliers helps WDFG to not just to place orders for stock, but to also communicate about new products, customer demands, marketing and advertising requirements. Communication between the retailer and the customer occurs physically via the airport outlets, but also through media, such as the WDFG website, and through social media, the latter also acting as a way for customers to engage with the retailer.

A further point of relevance was the lack of diversification in the business model. The canvas produced shows no sign of WDFG engaging in any activities that are not central to the process of selling products to airport users. This means that the company is highly reliant on the aviation sector in order to remain profitable. If their position in this sector weakens, or if the sector was to stop growing (or contract), then the entire WDFG business could be at risk.

From this model, and the dialogue that took place during the workshop, a number of observations relevant to the research can be made, and are presented in turn below.

- ***Airport passengers are the central customer segment.*** Airport passengers were identified as the primary customer segment in the WDFG business model as the rest of the business model is ultimately aimed at meeting their needs. The workshop identified a number of different potential passenger segments, including EU vs Non-EU passengers, business vs leisure passengers, and Domestic vs International travellers. The literature surrounding customer segmentation complicated this matter further with more segments detailed in a number of papers (for example M1ndset, 2014; Wagner, 2008; Freathy and O'Connell, 2012), such as those listed in

Table 5-1 below. Ultimately however, due to the context[47] of this research it was decided that it would be appropriate to amalgamate all passenger segments into one group, whilst remaining mindful of the different characteristics of each of the underpinning customer types.

This decision was based on a number of reasons. Firstly, the BMC literature does not state that this level of granularity is required, indeed, a number examples of customer segmentation found by the researcher (for example Kalakou and Macario, 2013; Osterwalder, 2004) often categorise customer segments rather broadly. Furthermore, although the some characteristics of each group may differ, they could all still be broadly described as members of the public, with a typically higher-than-usual propensity to spend, and a great deal of dwell time – although for many passengers (i.e. this on connecting flights, or those who arrive late to the airport, this may not be the case). Additionally, consultation with the WDFG Customer Analysis Officer identified that WDFG currently find it difficult to segment their customer base into the level of detail identified in the literature due to the vastly different characteristics present in each airport.

The other main customer segments identified were airport staff and product (supplier) brands. These can however be considered ancillary revenue streams that only exist as a result of the main activity of meeting passenger needs. Product brands (that may pay to advertise in store) are discussed further in Section 5.2.1.4. The emergence of WDFG employees as a customer segment revealed to the researcher that these employees make a significant number of purchases from the company – and highlighted the fact that this may cause issues with the sales data used in Chapter 6.

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[47] That is, the objective was to understand the WDFG business from a sustainability perspective rather than looking to say maximise product sales.

Table 5-1; Showing the customer segments found in the airport retailing sector (M1ndset, 2014).	
Segment	Characteristics
Emotional brand image shoppers	Very into brands and image – need well-known brands
	Like very much current airport offer (in airports with lots of shops and variety)
	Like exclusivity + international products with a local touch
	Want special editions
	High spenders, spend time in shops, visit frequently
	Buy spontaneously
	Need attractive shops, lots of choice and exclusivity.
Rational pre-planners	Buy their usual products to stock-up
	Can also buy usual products as gifts
	Very price sensitive (buy only if cheaper)
	Always compare with street prices
	Mostly pre-plan their purchases
	Do not seek exclusivity or novelty
	Often buy to use during trip
	Like simple and informative shops
	Don't spend time in shops
Local touch seekers	Seek authenticity
	Need local products (not cheap/ standard souvenirs)
	Not happy with the current airport selections
	Are the least brand sensitive
	Can also buy international products with local touch
	Buy mainly for gifting
Price sensitive shopping lovers	Need cheaper prices
	Compare with street prices
	Need promotions
	Brand and image sensitive
	Spend a lot of time in shops
	Like novelties
	Don't want local products
	Don't stock-up
Low income buyers	Low budget but still enjoy shopping
	Shop for well-known brands
	Buy predominantly for gifts
	Like guidance from staff
	Rely on promotions to make up for low budget
	Do not buy to 'stock-up'

- ***Customer mix requires a number of value propositions.*** The range of potential customer sub-segments identified in Table 5-1 above requires that the company offer a suite of value propositions in order to maximise revenues. On the one hand, the business is associated with luxury, exclusivity and speciality products that promote a sense of hedonism and an extravagance, in line with the psychological factors present with many shoppers when in the airport (Kim and Shin, 2001). Conversely, one of the models most important value propositions was its image of discount prices compared to the high street, due to items being 'duty-free' for those traveling outside the European Union. Likewise, the company stocks a wide range of products that may be found in the supermarket, being sold in the same space as some of the world's leading brands. Such a product mix is necessary for a company that attracts individuals of all demographics and lifestyles, and highlights that fact that any potential business model innovations will have to appeal to a wide audience.

As well as product range, product quality and availability were deemed as important value propositions in that they all promote trust between the customer and the retailer. Range and availability ensure that items passengers desire are always in stock, whilst product quality refers to the fact that WDFG sell genuine items – something that is not always true of local merchants at holidaying destinations. This suggests that company image is of vital importance to WDFG and they pride themselves on always meeting customer expectations.

- ***Limited customer contact reduces opportunity for enhanced revenues.*** The setting of WDFG in the airport means that the company is constrained, as compared to other forms of retailing, in terms of the type of relationships it can have with its customers. Firstly, only members of the public who are airport passengers are able to browse WDFG stores. This means that whilst the company may have access to a high number of passengers per year, they may do so only during dwell time, and on a small number of occasions per year, per individual (i.e. when they are about to fly). The nature of the airport means that activities such as check-in, security, boarding, and other retail concessionaire activities such as food and beverage, may reduce passenger time available to shop. This means that even when in the airport, passengers may be rushed, or stressed (Lin and Chen, 2013). This requires a convenient and fast Customer Relationship.

  Additionally, the physical setting of the airport, and the logistics and legislation that surrounds this environment also constrains the business. Firstly, the company is bound by its articles of association[48] to only sell goods within the 'airside'[49] area of the airport. This means that relationships and channels such as on-line retailing and home delivery are not possible. This has implication for the types Revenue Streams that WDFG can use to deliver their value propositions to their customers. The fact that duty and tax free regulations require customers must physical

[48] Defines the company's constitution, the responsibilities of the directors, the kind of business to be undertaken, and the means by which the shareholders exert control over the board of directors.
[49] i.e. beyond airport security.

ownership of products within the airport environment, for example means that WDFG rely on a direct, transaction only method of selling goods. Long-term revenue streams that could generate further revenues (for example, product leasing, rental, subscription, or repeat orders) are either logistically impractical, or legislatively prohibited. Equally, this has implications for WDFG in terms of changes they could make to their business model in order to reduce their carbon impacts and be more environmentally sustainable, as discussed in Section 1.2.2.

- ***The influence of brands.*** The brands that supply WDFG with products play an important role in the WDFG business model, identified in the Key Partners, Key Resources and Customer Segments elements of the canvas. These companies are often leading brands with a global reputation – in many cases they may be better known than WDFG themselves. This has a marked impact on the way in which WDFG engage with such businesses. Firstly, these brands often have their own brand image consultant who will visit WDFG stores to determine how products should be displayed. As it is in the best interests (financially speaking) of WDFG, airport operators, and the brands for sales to be maximised, this results in products often being brightly illuminated in store, and extravagantly presented to customers – resulting in high in-store energy usage. Furthermore, brands have complete control over the products they supply – in terms of their type, and how they are manufactured. For luxury brands, this means that many items are sold in premium packaging materials – such as glass – or in large display packaging for relatively small items. This suggests that there may be a number of ways in which WDFG may be able to engage with these brands from an environmental perspective, but may face obstacles in doing so; for example heavy glass materials could be replaced by plastic - but at the cost of lower perception of quality. Such brands have their own business models and sustainability strategies. If these do not correspond those being adopted by WDFG, this may impact upon the ability of WDFG to reduce the environmental impact of its own operations.

- ***Meeting airport demands is key.*** The relationship between WDFG and their airport landlords was a consistent topic throughout the workshop.

Notably, the location of the company in the airport (with access to a high-volume of willing to spend passengers) was raised as the most important value proposition central to the company's success. As stated above, WDFG have no diversification into other businesses. For its survival, it solely depends on the sale of products in specialist locations with access to high volumes of customers. As such, retaining access to this environment is of vital importance to company strategy – as further indicated by the listing of Airport Operators as a Key Partner, and through the entry of 'Winning Tenders for New Stores" in the Key Activities element. In this way, it can be appreciated how the company competes at two levels. As the main customer segment, WDFG must compete with other airport retailers, as well as retailers from outside of the airport setting, for the custom of passengers. Importantly however they must also compete with other duty-free retailers, to gain the rights to operate in the airport – gaining access to the passengers on whom their revenues rely. Accordingly, meeting the demands, wants and needs of airport operators is of vital importance – doing so increases the competitiveness of the company and the likelihood of bids for new or renewing contracts being accepted. For example, in the context of carbon management, an airport seeking to reduce its carbon emissions through participation on the Airports Council International Carbon Accreditation scheme, might favour retailers that are able to demonstrate carbon savings to the airport operator. This was experienced first hand by the researcher when asked to contribute to carbon calculations for a bid to operate at Tampa Airport, in the United States, as part of which WDFG had been specifically asked to demonstrate how it could contribute to carbon reductions at the airport.

- ***Limited space - requiring advanced logistical delivery system.*** Another feature of the WDFG business model commonly mentioned in the workshop was the requirement for a robust logistical delivery system. This is due to a combination of the high number of sales the company makes on a daily basis, and the limited space afforded to WDFG by their landlords. Limited space means that every square foot in the airport is a potentially valuable piece of land that could be used for other activities – for example the retail floor space, catering, passenger and aircraft handling. As a result, WDFG only have limited storage space, and consequently they require an advanced delivery network to ensure that products are always in stock. This requires stock levels to be accurately monitored so that necessary orders can be placed, and delivered on site, on a daily basis. This could be a potentially significant source of carbon from the company's current operations, and could be an important factor to consider in the assessment of alternative business models. The importance of the logistical system in maintaining stock levels is illustrated through the fact that trust in the company and availability of products were identified as key Value Propositions for the business. If customers are unable to find the items they would expect to be able to purchase, they may choose different retailing options in the future.

- ***The WDFG business model compared to business model archetypes.*** As discussed in Section 2.7, Weill *et al*., (2005) defined four overarching typologies of business model, categorised by the types of assets involved in the business. These are; Creator, Distributor, Landlord, and Broker (Weill *et al*., 2005). Each of these overarching categories can be commonly broken down into a total of 16 business models, as shown in Figure 5-3 below.

		What Type of Asset is involved?			
		Financial	Physical	Intangible	Human
What Rights are Being Sold?	Creator	Entrepreneur	Manufacturer	Inventor	Human Creator
	Distributor	Financial Trader	Wholesaler / Retailer	IP Trader	Human Distributor
	Landlord	Financial Landlord	Physical Landlord	Intellectual Landlord	Contractor
	Broker	Financial Broker	Physical Broker	IP Broker	HR Broker

Figure 5-3; Business model archetypes (Weill *et al*., 2005)

The WDFG business model sees the company ownership of stock, with limited or no transformation, followed by the subsequent sale to customers via their outlets. In these terms the WDFG business model can be seen as ubiquitous with typical retail trade – albeit trade that occurs within its own particular setting, with its own accompanying specificities. This conforms to the characteristics of Weill *et al.*, (2005) 'distribution' business model archetype, and specifically to the sub-archetype of Wholesaler/Retailer.

The WDFG business model could be described as having elements of four business model archetypes identified by Linder and Cantrell (2000):

- Price Model; WDFG sell products often at a discounted price compared to other retailers.
- Convenience Model; they provide a convenient service for those in the airport.
- Trust Model; reflecting the fact that WDFG offer genuine high-end products which customers can have confidence regarding the quality of.
- Experience Model; demonstrated through the fact that WDFG have developed a carefully designed user environment to attract customers who pay premium prices.

- ***WDFG have many differences from other 'brick and mortar' retailers.***
  As suggested above, there are number of differences between the WDFG business model, and those of other 'brick and mortar' retailers, such as those typically found on the high street. These can be summarised as :
  - Whereas high-street retail may only attract customers from a certain geographical region (and of given demographic characteristics), the position of WDFG in the airport means that their customer base potentially incorporates individuals of all demographics, and on a global scale. As such they must cater for a multitude of demands, via a number of value propositions. This has seen the company develop a unique situation whereby it is typically associated with both luxury, high-end products, and but also with cheaper, less exclusive brands.
  - The company is confined to a very specific area – the airport – with a number of implications, namely – lack of operating space, lack of storage/stock space, limited natural lighting, limited engagement opportunities with customers, and constraints in the way it can sell its products – i.e. it is not able to pursue on-line or home delivery sale opportunities. This results in constraints in the types of relationships the company is able to develop with its customers, with whom the company may only have limited physical contact time, and limited opportunities for engagement via other means.
  - Tight bonds exist between WDFG and their landlord airport operators – upon whom they are totally reliant. Whilst other retailers may have

access to a host of other retailing opportunities (i.e. a vast number of physical locations on the high-street and in retail parks – as well as on-line), WDFG have a relatively small number of sites where they are able to operate. Accordingly, competition to gain contracts to work with airports is intense, and retailers must develop business plans that are able to satisfy the demands of their partners, to increase the chance for successful bid and tender submissions.

- WDFG experience high-energy demands compared to other forms of retail. The company has little natural lighting in stores, and products are required to be brightly illuminated to increase sales. Additionally different parts of WDFG require different temperatures due to the vast range of products sold. Furthermore, as open-plan sites, these are working against the heating and cooling systems of the airport at large. This suggests that the company will have higher heating and cooling costs than similar, non-airport bound retailers. The limited storage space for the company, coupled with a large volume of sales means significant logistical environmental impacts.
- Finally, WDFG are unique to other retailers in that they are part of a complex and global industry with a number of different partners. These partners are often in competition with each other (for example WDFG face competition not just from other retailers, but from airlines that sell products on board aircraft, and for whom WDFG sales have an adverse impact on fuel costs and carbon emissions as described in Section 6).

5.2.2 Elements of sustainability in the business model.

Further analysis of sustainability activities in the business model can be made through Bocken *et al.,* (2014) sustainable business model archetypes, as introduced in Section 2.7. Table 5-2 summarises the eight archetypes, providing examples of how they have been applied in the wider retailing sector, after which each is discussed in turn, focussing on evidence of their implementation within the existing WDFG business model.

Table 5-2; Description of Bocken *et al.* (2014) Sustainable Business Model Archetypes, with examples of how these have been implemented within the wider retail sector.		
Archetype	Definition	Examples in Retail business models
Maximise material and energy efficiency	Do more with fewer resources, generating less waste, emissions to air and water pollution.	The Co-Op have a long history of implementing low-carbon solutions in their business models. The company has for example saved £50m per year by installing doors on a number of previously open shop-floor fridges[50]
Create value from waste	The concept of 'waste' is eliminated by turning waste streams into useful and valuable input to other production and making better use of under-utilised capacity.	Argos pay customers for the return of old electronic equipment that can be recycled and put back into the supply chain.[51]
Substitute with renewables and natural processes	Reduce environmental impacts and increase business resilience by addressing resource constraints 'limits to growth' associated with non-renewable resources and current production systems.	The Marks and Spencer Cheshire Oaks store is partially constructed out or renewable materials[52]. The Cooperative Group headquarters in Manchester hosts one of the largest photovoltaic arrays on a building in the UK and the company sources 98% of its energy from renewables[5]
Deliver functionality rather than ownership	Provide services that satisfy users' needs without having to own physical products.	Girl meets dress is an on-line retailer that enables customers to rent premium brand garments.[53]
Adopt a stewardship role	Proactively engaging with all stakeholders to ensure their long-term health and well-being.	Walmart have an award winning supply chain engagement policy that requires all partners to meet strict sustainability criteria[54]
Encourage sufficiency	Solutions that actively seek to reduce consumption and production.	B&Q have launched as 'street-club' scheme for individuals to share use of DIY products[55]
Resource for society / environment	Prioritizing delivery of social and environmental benefits rather than economic profit (i.e. shareholder value) maximisation.	Oxfam return all profits from retail towards pro-social activities[56]
Develop scale up solutions	Delivering small sustainable solutions at a large scale to maximise benefits for society and the environment.	Fair Trade branded items see local individual producers paid a fair price for their goods, on a large scale, across a multitude of retailers[57]

- **Maximise Material Resource and Energy Efficiency.** This archetype is the one most closely aligned to the current WDFG business model. The company is already implementing initiatives on energy minimisation, waste reduction and recycling, reduced materials usage and logistical-fleet fuel efficiency. These can be considered something of a 'business as usual' approach in that they address sustainability issues incrementally, whilst allowing the current business model to continue relatively unimpeded, at the same time gaining cost savings in the bottom line – as well as helping reduce energy demands (and emissions) of airport operators.

[50] http://www.co-operative.coop/our-ethics/2014-sustainability-performance/
[51] http://www.argos.co.uk/static/ArgosPromo3/includeName/gadget-recycle.htm
[52] http://corporate.marksandspencer.com/plan-a/e8c4c103e9884a729ba3db17aa8e4ac7
[53] http://hire.girlmeetsdress.com/pages/how-it-works
[54] http://www.ethicalcorp.com/communications-reporting/wal-mart-giant-retailing-shakes-supply-chain
[55] http://www.diy.com/corporate/community/streetclub/
[56] http://www.oxfam.org.uk/what-we-do
[57] http://www.fairtrade.org.uk/

- **Creating value from waste.** WDFG currently collect, segregate and recycle the majority of their waste, with non-recyclable waste returned to the Central Distribution Centre for incineration (providing energy at that site).
- ***Maximise Material and Energy Efficiency*** Some evidence through activities aimed at reducing emissions through their distribution network (i.e. through the use of the highest efficiency delivery fleet possible), and direct energy usage (for example, through efficient in-store lighting provision).
- ***Resource for society / environment.*** WDFG is firmly focused on profit maximisation, however they have engaged in a number of Corporate Social Responsibility activities, notably their charitable division, the “One Foundation”. This initiative seeks to fund clean water projects around the world through the sale of ‘One’ bottled water, and by the end of 2014 had raised over £1.4m for this cause.
- ***‘Adopt a Stewardship Role’.*** Evidenced through the company’s work through the Heathrow Sustainability Partnership, which sees the business work with a number of airport partners in order to enhance the environmental sustainability of airport retailers at Heathrow Airport.

The identified WDFG business model shows no evidence of the ‘*Encourage Sufficiency, Scale Up Solutions’,* and *Deliver Functionality Rather than Ownership’ archetypes.*

This above suggests that from a natural resource perspective, the WDFG business model , in its current state at least, cannot be classed as ‘sustainable’ in the longer term, when compared with the definitions put forward in Sections 2.3 and 2.7. The model certainly does not appear to meet the Stubbs and Cocklin (2008) definition where “sustainability concepts shape the driving force of the firm and its decision making” (Stubbs and Cocklin, 2008;103).

This is not to say that WDFG is performing poorly in sustainability terms compared to their peers within the retail sector, indeed its energy, wastes and vehicle logistics management programmes appear to be ‘leading edge’ based on a number of awards the company has received (WDFG, 2014a). Like many businesses, WDFG is taking incremental steps towards sustainability, based on present market and legislative conditions, by maintaining the structure, activities, and resources that underpin their existing (and profitable) business model. Indeed, efforts in this field to date could be described as illustrating how the company is learning to deal with sustainability issues and is in the process of developing "internal structural and cultural capabilities to achieve firm-level sustainability and collaborate with key stakeholders to achieve sustainability for the system that an organisation is part of" (Stubbs and Cocklin, 2008;103).

5.2.2.1.1 Barriers to the adoption of a more sustainable business model

The research has identified a number of barriers that may limit the potential for sustainable innovations in the WDFG business model.

- ***Constraints of the airport setting.*** All of the barriers discussed below are ultimately rooted in the fact WDFG are confined to the airport environment. This setting poses a number of constraints to potential business model innovations. Limited space means that innovations would have to be physically small in scale, and could not require significant on-site storage. Limited customer contact and dwell time means innovations must facilitate a fast and convenient transaction. Limited natural lighting has implications for reducing energy use by increasing natural light. Finally, the fact that passengers can only purchase items post-security means that retailers can only sell items on a one-off basis, with direct transfer of products between the retailer and the passenger occurring on site. Leasing, subscription, product recycling, and other type of customer relationships and revenue streams would not be suitable. Additionally, the fact that the transaction for products must occur within the airport means that the majority of products sold by the company will end up on aircraft, and accrue additional fuel burn for airlines as a result of them carrying extra weight. This has fuel cost and carbon implications for airlines that are, in the current WDFG business model, unavoidable, other than through the provision of their 'collection on arrival' service. This sees customers place their order for a product before departure, and collect it when they return from their journey. This scheme has the potential to reduce the amount of weight taken onto aircraft, but it's application is limited by the fact that passengers must return to the same airport, and such an offer is less appealing to many customers as it goes against impulsivity – a key determinant in the willingness to buy of airport shoppers.

- ***Reliance upon luxury, exclusivity, and specialist products.*** The brand and image of WDFG, many of their suppliers, and the aviation experience as a whole (in many parts of the world), is one of luxury and opulence. When coupled with passenger demand for luxury items, the potential difficulties in moving away from this market (which gives rise to higher environmental impacts) can be seen. Doing so would impact upon sales, brands might be unwilling to change their image to suit retailer needs, and airport operators may oppose any innovations that reduced their own revenues.
- ***The psychological state of customers.*** Airline passengers typically have a more 'hedonistic' attitude than high-street shoppers – particularly those who may be flying for leisure purposes (Newman, 1997). As a result, engaging with them with the aim of facilitating behavioural change is likely to prove difficult.
- ***Required focus on consumption.*** Levels of consumption and the sale of goods, rather than services, is widely recognised as being one of the key challenges for sustainable development, however this is the primary driver of revenue for WDFG . Moving away from this business model would require radical innovation and a move into new markets in which it currently possess no expertise. Secondly, the high demand for the products sold by WDFG means that such change would be unlikely to deliver the level of return derived from the current model or meet the contractual requirements of airport operators. The potential for WDFG to change from a consumption-focused model would therefore be minimal at the current time This suggests that it needs to find sustainability solutions within the existing model of asset sale to passengers.

To summarise, this research demonstrated that new more environmentally sustainable business models for WDFG, would also have to be commercially and operationally sustainable. Accordingly, a list of criteria to assess the viability of new business models was created, as illustrated in Table 5-3 and used throughout Chapter 7.

Table 5-3; Criteria that potential new business models for WDFG would need to comply with to be commercially and environmentally sustainable.	
Criteria	Description
Sustain current revenues and support business growth (Commercial sustainability)	Delivering financial returns is a key imperative for WDFG, in terms meeting the demands of their shareholders and those of the airports to whom they are tenants. Accordingly, new business models must; be low risk in terms of implementation (in terms of the scale of change and the threat of new entrants), meet customer expectations and supplier demands, reduce bottom line costs, and generate as a minimum current revenues for WDFG and for airport operators. Additionally, models must support growth of both revenue streams in existing stores, and through the acquisition of new contracts.
Fit within the specific operational constraints of the airport (Operational sustainability)	Any new business model must fit within the particularities of the airport operating environment, for example limited operational space, the fact the WDFG have limited customer contact time, the diverse nature of the customer base, security requirements, and legislative constraints regarding the sale of duty free.
Reduce energy use and carbon emissions for airport landlords (environmental sustainability)	Airport operators are under increasing pressure to reduce CO_2 emissions from their sites to ensure growth. It is in the commercial interests of WDFG to reduce the carbon intensity of its operations to support such the efforts thereby enhancing the attractiveness of its tenders to new airports. Energy conservation, can deliver direct financial benefits and purchase of renewable energy carbon benefits.
Reduce fuel use and carbon emissions for airlines (environmental sustainability)	WDFG need to reduce the growth in airline fuel use and carbon emissions for environmental, economic and political reasons. New business models must either minimise the weight of products purchased in WDFG outlets taken onto aircraft, or mitigate that weight through carbon offsetting.

5.2.3 Summary

The previous chapter identified that the WDFG business strategy has a focus on three aspects; the retail travel industry, controlling key geographical markets, and developing strong partnerships - particularly with airports and product brands. The BMC, identified in the workshop, is well suited to meeting these goals, in that the entire canvas is focused on travel retailing, with the winning and renewal of contracts a key activity, and with an acknowledgement that airport operators and product brands are key partners central to success. Additionally, the canvas illustrates a strong understanding of the different needs of its customers, and has a variety of value propositions to match. Furthermore, the company is well aware of the logistical constraints of operating in the airport, and have developed a robust and award winning delivery system as a result. Additionally, they employ a large number of sales staff to account for the fact that they present a large and diverse offering and can have limited contact time with passengers.

Further analysis of the key elements of the WDFG business model is possible by comparing the BMC to the five business model components the company identified in its 2014 Company Brochure (WDFG, 2014) as being central to achieving its business strategy. Each of these were demonstrated through the BMC produced during the workshop:

- *Airport partnerships*; detailed as a key partner for the organisation, with a key activity being to maintain strong partnerships.
- *Stunning stores*; store design was detailed as a key activity for the company, as well as being identified as a key issue in the cost structure. Reference to this was also made in the workshop regarding meeting customer expectations.
- *Brand expertise*; the workshop identified that brand partners have a major influence upon store design, and the presentation of their products.
- *Customer focus*; the whole BMC is ultimately geared around satisfying customer expectations and demands, with a number of value propositions focused on maximising customer propensity to buy.
- *Skilled People*; the company was keen to include their highly skilled workforce in the canvas, and see them as a key value proposition of the organisation, rather than a key resource, due to their importance in meeting customer expectations, that is, by being able to provide high-level support, across a number of product ranges.

The above suggests that the WDFG business model is well aligned to delivering the corporate strategy. Additionally, there was a great deal of synergy between the canvas and the business model components that are identified in the company's published materials; indicating that the business model has been effectively disseminated throughout the company (at least as far as those people who attended the workshop).

The value propositions offered by the company satisfies the 'jobs, pains and gains' (see Osterwalder and Pigneur, 2010) of their many different customers, meaning that although segmentation is difficult, it will be able to satisfy different customer requirements, to at least some degree. Some value propositions appeal to all customer segments (for example location, and price), whilst others are tailored towards specific audiences (for example expensive luxury products for the wealthy, or speedy and convenient service for those short on time and who do not shop for pleasure). These propositions are relatively easy for a competitor to imitate, and are likely to be already used by other airport retailers. Differentiating the value proposition in some way to provide something that is unique and preferably hard to copy, would improve the company's competitive advantage, in the terms of winning and renewing operating contracts. Sustainable innovations designed to reduce the environmental (carbon implications) of airport retailing could be the mechanism by which the company is able to do this, particularly as airport operators and airlines seek to actively reduce and demonstrate reductions in their CO_2 emissions.

Application of the BMC to WDFG and a review of the literature reveals that this company operates within a highly specialised field and that it is very well adapted to this niche market as evidenced by its strong growth and healthy profits. As indicated elsewhere in this thesis, however, the commercial world in which WDFG operates, and the natural environment in which it operates, is changing and this could threaten the longer-term sustainability of the company unless it is able to evolve its current business model. It is, however the very specialism that has made it so successful, that could act as a barrier to its ability to change and adapt, in particular to the issues of climate change and peak oil as discussed later in this thesis.

5.3 Conclusion

The BMC workshop can be considered as having been a successful exercise. A detailed business model of WDFG activity was generated along with an understanding of how the current business model engages with the sustainability agenda, and barriers to future innovation. As such, it can be seen that Research Objective 1; *"Understand the incumbent business model of airport retailers and identify the characteristics that differentiate the sector from other forms of retailing"* has been appropriately addressed. Based on this business model, the following chapter looks to quantify the emissions that arise from WDFG activity, before identifying potential new business models that may enhance the environmental sustainability of the company, in Chapter 7.

6. Research Phase 3; quantifying WDFG carbon impacts

6.1 Introduction

The last chapter defined the WDFG business model, providing context surrounding current WDFG activity, and informing on where the carbon impacts of WDFG activity are likely to arise. This chapter builds on this by identifying the carbon implications of WDFG activities at Manchester Airport, in line with Research Question Two; *“Determine the environmental and economic consequences of airport retailer business models”* and Research Phase 1c, as set out in the Methodology, and illustrated in Figure 6-1 below.

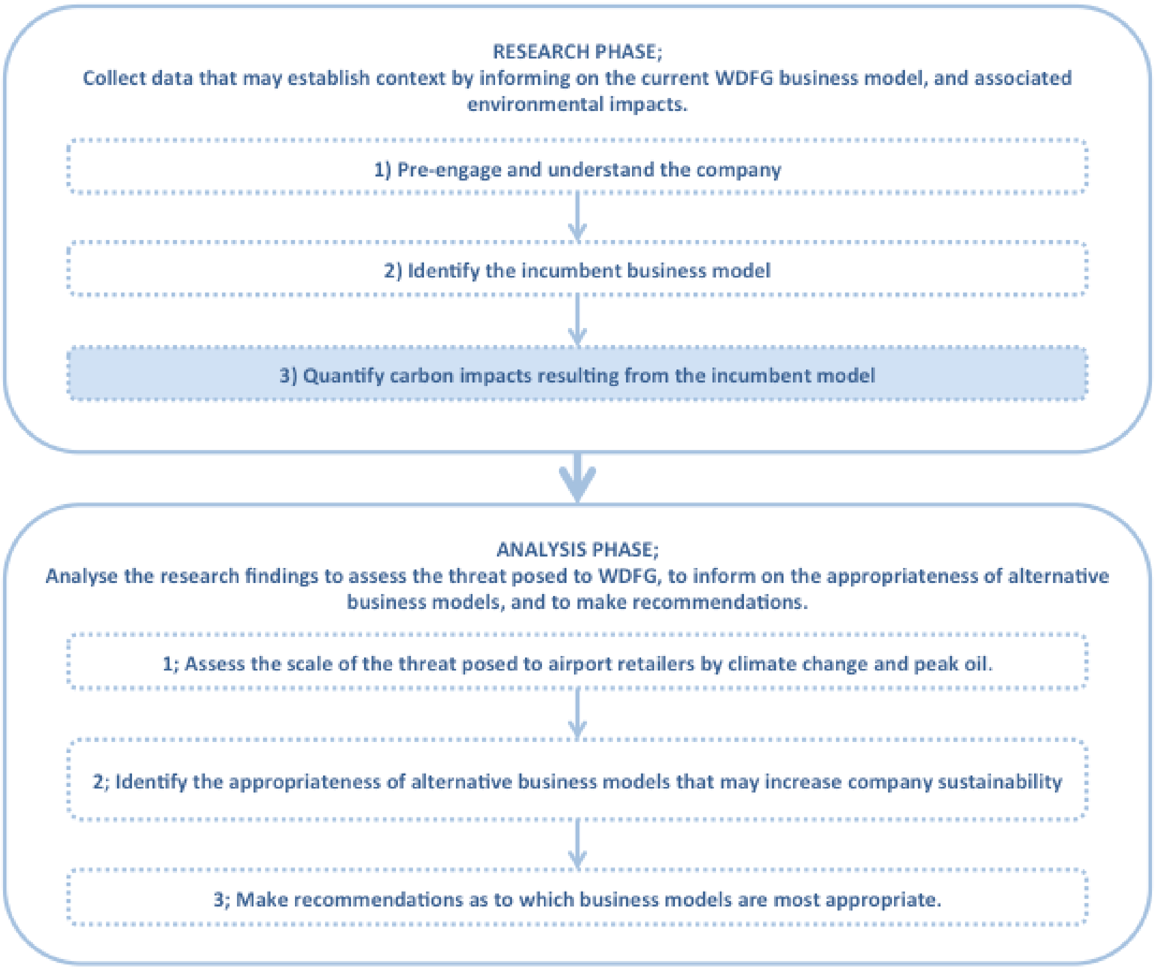

Figure 6-1; illustrating how this chapter addresses research phase 1c in the present research.

6.2 Supporting concepts

6.2.1 Environmental accounting

For organisations that are looking to reduce their environmental impacts, a vital activity is monitoring and measurement. Doing so helps to establish baselines[58], set targets, and to monitor progress over time (WBCSD & WRI, 2004). With respect to climate change concerns, such accounting is often conducted by measuring the amount of carbon dioxide that is emitted by the activities of an organisation. In recent years, carbon dioxide has become the main proxy by which most businesses have their climate change impacts assessed. This is because CO_2 is the predominant driver of climate change of all the greenhouse gasses (GHGs) identified in the Kyoto Protocol (1992)[59]. The gas has the highest radiative forcing[60] of all climate change drivers (IPCC, 2007) and has the potential to remain in the atmosphere for hundreds of years from the point of emission (IPCC, 2007). Furthermore, the impacts of other GHGs can be taken into consideration in CO_2 accounting, by measuring not in units of CO_2, but in carbon CO_2 equivalent (CO_2e)[61] produced via the business activity. A common tool in investigating the carbon output of a firm is that of carbon footprinting, described by Wright *et al.* (2011) as;

"A measure of the total amount of carbon dioxide (CO_2) and methane (CH_4) emissions of a defined population, system or activity, considering all relevant sources, sinks and storage within the spatial and temporal boundary of the population, system or activity of interest. Calculated as carbon dioxide equivalent (CO_2e) using the relevant 100-year global warming potential (GWP100)."

Wright *et al.* (2011),

58 A hypothetical scenario for what GHG emissions, removals or storage would have been in the absence of the GHG project or project activity (WBCSD & WRI, 2004).

59 An international treaty, which extends the 1992 United Nations Framework Convention on Climate Change (UNFCCC) that commits State Parties to reduce greenhouse gases emissions, based on the premise that (a) global warming exists and (b) man-made CO2 emissions have caused it (UNFCCC, 2015)

60 See Footnote 26.

61 A proxy by which the impacts of other GHG's may be incorporated into a CO2 measure, based on their impact on the Earth's atmosphere.

Where data can be secured (often a difficult process in itself), conducting a carbon footprint is a relatively straightforward process, in which an amount of activity is multiplied by a corresponding emissions factor that is representative of carbon emitted from that activity:

$$E = AD*EF$$

Where;

E - Emissions of GHGs that result from business activity
AD – Activity Data; The amount of activity that has taken place
EF - an emissions factor that is representative of a given amount of GHGs emitted per unit of activity.

6.2.2 Sources of emissions

As illustrated in Figure 6-2, the Greenhouse Gas Protocol (GHG Protocol) categorises GHG emissions into one of three 'scopes': Scope 1 (direct GHG emissions from an organisation's activities), Scope 2 (electricity purchased by an organisation – considered indirect GHG emissions) and Scope 3 (other indirect GHG emissions associated with the activities of the organisation).

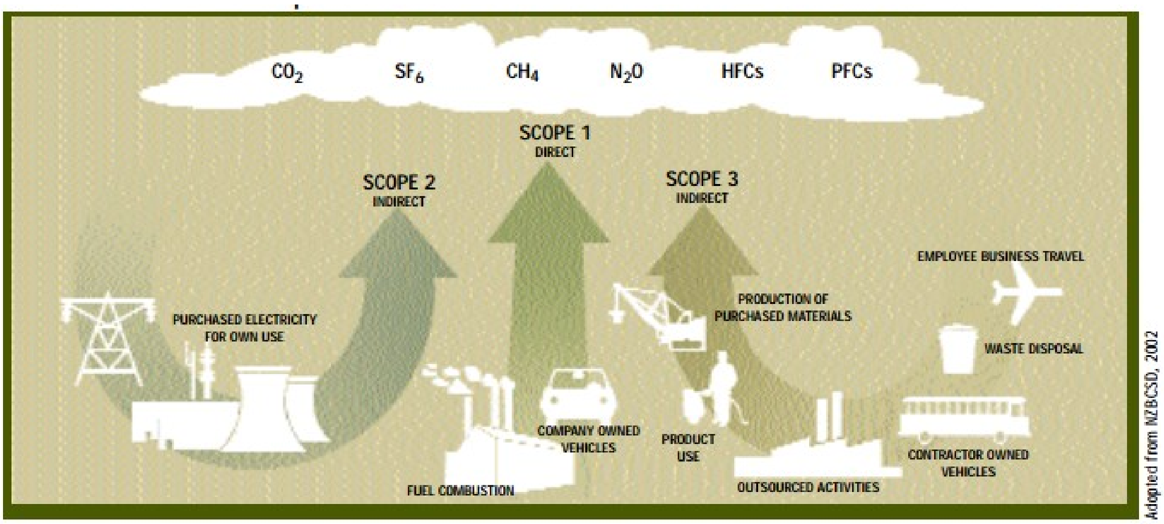

Figure 6-2; illustrating the GHG Protocol GHG Emission Scopes (WBCSD & WRI, 2004).

The operational boundaries of firms that are attempting to calculate an emissions inventory define which emissions from these categories are to be included in the assessment. Scope 1 and 2 emissions are mandatory reporting requirements for companies that are seeking to be compliant with the standard (WBCSD & WRI, 2004).

Under the GHG Protocol, the range of emissions relevant to each scope may vary on a company-to-company basis, and may include (WBCSD & WRI, 2004):

- ***Scope 1; Direct emissions;***
  - Generation of electricity, heat or steam by the company.
  - Physical or chemical processing.
  - Emissions resulting from combustion of fuels in company owned/controlled mobile combustion sources that are used for transportation of materials, products, waste and employees.
  - Fugitive emissions as a result of certain emission releases of the organization, like air-conditioning or refrigeration units.
- ***Scope 2; Indirect electricity emissions;***
  - Electricity and gas purchased by a firm, which is used as "shorthand for electricity, steam and heating/cooling".
- ***Scope 3; other indirect emissions arising from;***
  - Extraction and production of purchased materials and fuels.
  - Transport-related activities.
  - Electricity-related activities not included in Scope 2.
  - Leased assets, franchises and outsourced activities.
  - Use of sold products and services.
  - Waste management and disposal.

The sources from which Scope 1 and 3 emissions may arise are similar, however Scope 1 emissions result from activities directly undertaken by the company under investigation, whereas Scope 3 are the product of the activities of another company (or individual) – but that arise because of the focal firm. For example, in the context of this research, Scope 1 emissions may arise from the burning of fossil fuels in the transport of products from the WDFG central distribution centre to their retail outlets. On the other hand, increased burning of fossil fuels by aircraft that arise as a result of additional weight being taken onto aircraft by WDFG customers, would represent Scope 3 emissions. These emissions are not ultimately the responsibility of WDFG, but their existence nonetheless results directly from the WDFG business model.

Carbon accounting is further complicated by the fact that some emission sources may be present as both Scope 1 and 3 emissions, for example, the Scope 3 emissions of WDFG associated with products being taken onto aircraft will be Scope 1 emissions for airline operators. The result is that Scope 3 emissions are not a mandatory reporting component of the GHG Protocol, albeit the Protocol guidance does stipulate that companies should look to account for and report on those activities that are relevant to their business and goals, and for which they are able to obtain reliable data (WBCSD & WRI, 2004). The climate change challenge requires that all sources of carbon emissions are reduced, whether they be Scope 1, 2 or 3 for a given organisation. Furthermore, a company may find it easier to reduce Scope 3 emissions than to reduce its Scope 1 emissions, by working with its service partners. As such, the quantification of Scope 3 emissions, where possible, is a valuable exercise in the context of meeting the climate challenge. Additionally, monitoring of Scope 3 carbon impacts “provides an opportunity to be innovative in GHG management” (WBCSD & WRI, 2004:29).

6.2.3 Carbon accounting tools

The previously mentioned GHG Protocol, developed by the World Resources Institute (WRI)[62] and the World Business Council for Sustainable Development (WBCSD)[63], is one of a number of carbon accounting tools available for use by researchers and practitioners. A number of other methodologies for calculating carbon emissions also exist (see Table 6-1). These differ predominantly in the scale of their implementation, with guidelines set by the Intergovernmental Panel on Climate Change[64] looking to quantify emissions on an international level, through to the GHG Protocol aimed at facilitating GHG inventories for individual organisations, whilst PAS2050 aims to help GHG quantification at an individual product or services level.

62 www.wri.org/
63 www.wbcsd.org
64 http://www.ipcc.ch/

Table 6-1; Examples of carbon accounting frameworks and tools (authors own)	
Example	Description
GHG Protocol (WBCSD & WRI, 2004).	Environmental accounting tool designed for international application, and adopted in the USA as the primary GHG emissions accounting tool for businesses. Process and activity based, with emissions factors retrieved from a number of sources. Distinguishes emissions in some detail as being Scope 1-3 in nature (see above). Scope 3 emissions voluntarily reported, but recommended submission where possible and accurate.
Publicly Available Specification (PAS 2050) (BSI, 2011).	An attempt to develop a carbon accounting tool by DEFRA the Carbon Trust, and the British Standards Institute (BSI to measure the GHG emissions embodied in products and services across their entire life cycle. Product and services focus means that it is less useful as a tool for organisations to calculate their carbon impacts. Only provides general guidance, rather than an explicit framework, failing to help develop an actual carbon inventory.
DEFRA carbon footprint standards	Defines emissions sources as Scopes 1-3, as per the GHG Protocol, albeit with some differences regarding the classification of direct and indirect emissions.
IPCC guidelines on reporting GHG emissions	Predominantly used for carbon impact appraisal at the national or corporate levels. Indirect emissions are classified based on emissions that contribute to climate change indirectly, for example radiative forcing from aviation, rather than the activities that result in such emissions themselves. States that all emissions are should be mandatorily reported. Uses a single emissions factor database with data derived from limited sources (for example the US Environmental Protection Agency), causing issues when applying these factors in different areas (for example the United Kingdom).
ISO 14064-65	Similar to the GHG Protocol Hodgson and Gore (2007), but differs in that it separates Scope 3 emissions into the additional subgroups of being either relevant to an organisations supply chain, or being related to the final use and disposal by the consumer, rather than combining the two into the same 'scope'. Does not, like the GHG Protocol, detail how estimates on actual carbon emissions may be calculated. Rather it acts as guidance on how carbon foot printing may be assessed and reported.

As this chapter looks to perform carbon accounting at an organisational level, and considering the similarities of the existing accounting literature, the GHG Protocol appears to have most relevance to this research. It is developed for the appropriate scale of investigation, is widely used around the world, and is built around a robust, regularly updated framework. Furthermore, the three emissions Scopes identified in the GHG Protocol act as a useful means by which one may classify and analyse WDFG's environmental impacts, and compare them to other organisations.

6.3 Carbon calculation methodology

The GHG Protocol provides a linear framework through which it is possible to calculate GHG emissions for a given business. The way the researcher applied this process in the present research is illustrated Figure 6-3, and is introduced in more detail below, with the approach taken for each of WDFG emissions sources identified.

Figure 6-3; The five phases of the GHG Protocol calculation framework (authors own; after WBCSD & WRI, 2004).

6.3.1 Boundary setting, reporting period and emissions sources

An important aspect of carbon accounting, and one specifically referred to in the GHG Protocol (WBCSD & WRI, 2004), is that of boundary setting. This refers to the process of defining the organisational boundaries within which one may measure and report carbon emissions. Based on the business model and activity chain of WDFG identified in the previous phase of the research, it is possible to determine the boundary of activities for which WDFG may be directly responsible for carbon emissions. These are highlighted in Figure 6-4 below. The boundary includes all WDFG activities that arise from company operations at Manchester Airport (in accordance with the research case study methodology described in Chapter 2.8). This starts with the distribution of products from the company's Central Distribution Centre (CDC), and includes all WDFG activities that occur within the airport, pertaining to the storage and sale of products, administrative activities in the airport, and distribution of products, by passengers to destinations via aircraft.

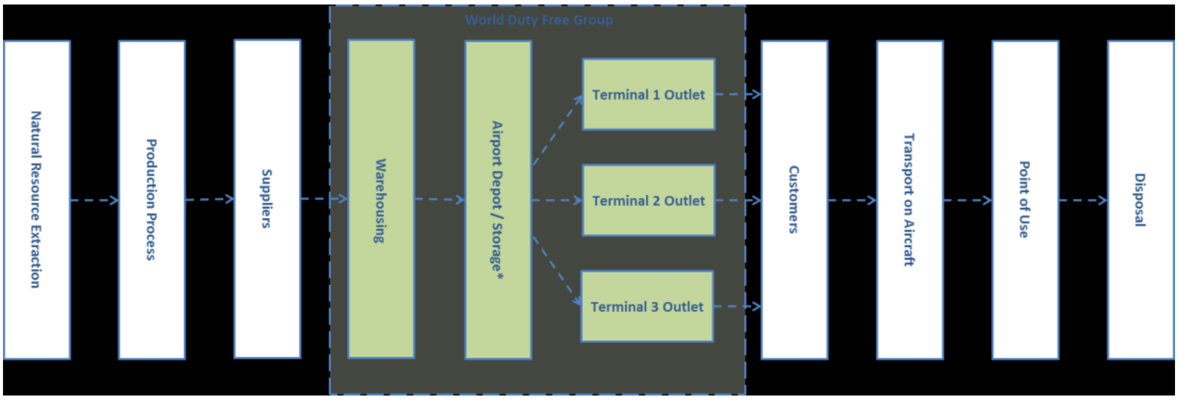

Figure 6-4; Illustrating WDFG direct ownership of emissions in the businesses activity chain

This boundary has been set according to the 'control' approach advocated in the GHG Protocol. Under this approach, a company accounts for 100 per cent of the

GHG emissions from operations over which it has control. It does not account for GHG emissions from operations in which it owns an interest but has no control over. It is for this reason that the emissions that result from WDFG products taken onto aircraft have been included as Scope 3 emissions in these calculations. Whilst the company is not strictly responsible for these emissions (direct responsibility lies with the airline passengers and airline operators), such emissions are ultimately an outcome of the WDFG business model, and are ones that could potentially be avoidable through alternative business models.

Upstream emissions[65] from product manufacture, going as far back to natural resource extraction, production and transport to WDFG were excluded from the calculations. This is because these emissions are beyond the control of WDFG, other than the limited capacity the company has to engage with its supply chain in terms of how they manufacture package and transport products to them. The variety, quantity and source of products sold by WDFG is so great that calculating this carbon impact extremely complex and would be of limited relevance in the context of this research project.

The research will consider upstream emissions from energy usage; that is, the emissions that result from, energy used by WDFG being extracted, produced and transported to the organisation. Such emissions have a direct correlation with the amount of energy used by the company, and are easily calculated through the use of a DEFRA Well-To-Tank[66] emissions factor (DEFRA, 2015).

6.3.1.1 Reporting period

The figures used in the carbon inventory calculations for this research project represent those arising during one year of WDFG operations. Due to issues surrounding the availability of data, and the number of assumptions used however, the period of data used in for each emissions source differs from calculation to calculation - as illustrated in Table 6-2. In each calculation’s phase, the researcher applied most recent 2014 DEFRA conversion figures to ensure that the emissions

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65 That is, those emissions that occur before the scope of the organization under observation ((WBCSD & WRI, 2004),

66 Well to Tank emissions refer to those emissions that arise in the process of extraction of natural resources from the ground, their production into usable products (i.e. fuels), and their transportation to point of use.

figures produced would be of most relevance to likely current emissions levels. Additionally, where possible, the researcher modified figures to represent likely 2014 emissions; for example, emissions from products taken onto flights were based on Manchester Airport growth to account for the fact that sales of products by WDFG in the airport would likely have increased by a similar amount.

Table 6-2; Emissions scopes and reporting periods for WDFG activities at Manchester Airport				
Scope	Emission	Context	Period	Justification
Scope 1	Emissions from delivery vehicles.	These vehicles transport the products sold by WDFG from their bonded warehouses, to individual airport terminals on a daily basis.	2014	Most recent period to which the research could obtain any relevant data.
Scope 2	In store energy usage	WDFG receive energy from the airport operator, which acquires this from an energy utility provider, via the national grid. WDFG have limited control over this provision (in that they may be able to pressure the airport into providing energy from renewable sources), and are charged collectively for all activities per terminal. This makes further analysis is difficult.	Oct 13 - Sept 14	The most recent 12-month energy usage recorded by the organisation.
Scope 3 emissions Included	Energy Usage indirect emissions	Whilst the emissions that arise from energy usage by the company predominantly represent Scope 2 emissions, they also result in Scope 3 emissions, through the transport and distribution of energy across the national grid (which results in additional carbon emissions and energy loss), and from the extraction of such emissions and the 'production' of such energy through refinement of natural resources into usable energy.	Oct 13 - Sept 14	The most recent 12-month energy usage recorded by the organisation.
	Water Usage and Treatment	Water usage as part of WDFG operations at the airport was included as a Scope 3 emission that the water itself carries no direct carbon impact, but its extraction/storage, purification, transport and usage does.	2014	The most recent data available to the researcher.
	Waste Disposal	The handling of waste produced by WDFG operations is also included as a source of Scope 3 emission in line with Scope definition as an 'other direct emission'.	2014	Most recent period to which the research could obtain any relevant data.
	Business Travel	Business travel by WDFG employees was an area with significant lack of data provision in that; there was no record of individual trips taken, distances travelled, or modes of transport used. Such failings were due to a lack of reporting and monitoring systems.	2014	An assumption laden calculation based on the advice of the WDFG Environment officer's knowledge of business travel figures at Manchester Airport
	Staff Commuting	WDFG were able to provide a list of employees who work at their Manchester Airport sites, and the home postcodes of such employees. This enabled the distance travelled per employee to be calculated. The company did not have any data pertaining to how staff made such commutes. Overcoming this barrier involved finding staff commute data for the airport as a whole, and applying this to the WDFG employee database.	2014	Most recent period to which the research could obtain any relevant data.
	Impact of weight being taken onto aircraft	Calculating these emissions was a complex process for which no pre-existing methodology has been represented in the academic literature. Whilst WDFG were able to provide data regarding which products were sold at their stores, and the destinations to which such items were flown, a number of assumptions had to be made for example, regarding the specific routes flown, types of aircraft flown, and payloads of passengers on board each aircraft. Accordingly, these emissions are explored in more detail in Section 6.4.3.	2010	Testing of the Polls Theorem[67] calculation method required a great deal of data input. The earliest the researcher was able to obtain this data for was 2010.
Scope 3 emissions not included	Product Usage and disposal	The usage and disposal of products sold by WDFG were deemed beyond the scope of this research due the vast range that would make a full Life Cycle Assessment impossible to conduct, given the logistical restrictions of the research	N/A	N/A
	Natural resource extraction, production and transportation of goods to WDFG	As above, these emissions were considered outside of the scope of the present research project in that doing so would be beyond the researchers capabilities in terms of the time and resources available for the study.	N/A	N/A

67 See Section 6.4.3.2.2

6.3.1.2 Identify GHG emission sources

Based on the engagement and business model canvas phases of the research with WDFG, a number of emissions sources were identified from the WDFG business. Each of these were compared to the three GHG Protocol Scopes to identify which were relevant to the organisation and the research. These emissions are highlighted in Figure 6-5 below and summarised in Table 6-2 above.

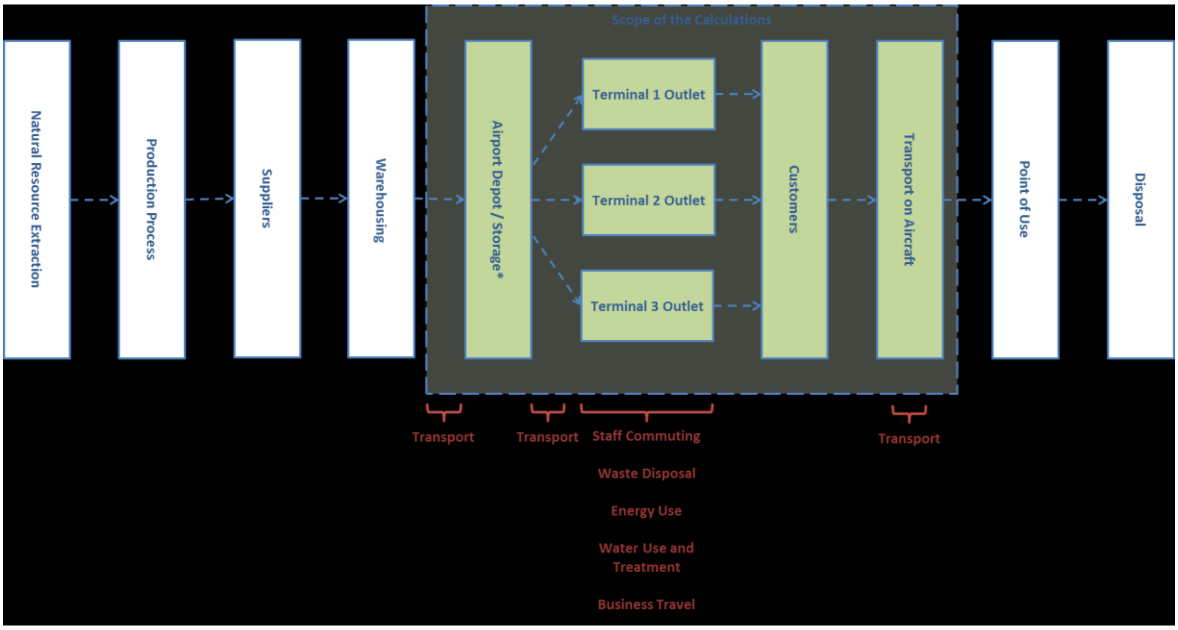

Figure 6-5; Emissions arising from WDFG activity at Manchester Airport. Illustrating the boundaries of each emission type and their inclusion in the present research.

6.3.2 Select a GHG emissions calculation approach

The GHG Protocol does not stipulate a specific calculation method, but states that the most common approach is through the application of documented emissions factors. Accordingly, activity data for the source of each emission was collected, and multiplied by CO_2e conversion factors from DEFRA (2014), following the process described in Section 6.2.1. The approach to the calculation of each emission source is described through Sections 6.4.2.1 to 6.4.2.6.

6.3.3 Collect activity data and choose emission factors

Activity data (describing the quantity of a particular activity, for example energy usage) can be obtained in a number of ways, with most companies doing so through simple monitoring systems. Scope 1 and 2 GHG emissions can for example be obtained from purchased quantities of fuels (i.e. vehicle fuel, or electricity and gas from a utility supplier). Scope 3 emissions on the other hand are typically obtained from activity data such as passenger miles travelled, or via published 3rd party data. In this research, where possible, activity data were directly sourced from WDFG. Where assumptions had to be made the researcher was careful to highlight these and justify their use.

Emission factors (which allow the activity quantity to be converted into CO_2e data) were taken from official figures produced by DEFRA (2015) for the British Government. This concise list of conversion factors covers a host of organisational activities that are likely to derive some volume of GHG emissions for example; energy usage, water usage and treatment, and vehicle transport. Such factors are commonly used in practice, and arising from a UK governing body, can be assumed highly accurate.

6.3.4 Apply calculation tools

More than one tool was required to calculate the emissions from all WDFG activities. This is in line with the GHG Protocol, which states that practitioners may substitute their own methodologies as appropriate on a case-by-case basis, so long as they are consistent with GHG Protocol standards regarding data robustness. Details of how each tool was applied in the research study are provided in the following section.

6.4 Findings: indirect and direct carbon impacts at WDFG

The results of the carbon accounting of WDFG operations at Manchester Airport are described below. First, 'on-the-ground' emissions are calculated. Second, the emissions resulting from WDFG products being taken onto aircraft are presented by analysing the products and weight sold by WDFG (solving a number of data issues in the process), selecting a calculation methodology, and performing the necessary calculations.

6.4.1 WDFG emissions quantification; summary

A summary of the results of a comprehensive GHG inventory conducted according to the GHG Protocol guidelines are presented in Table 6-3.

Total direct and indirect emissions for the one year study period was 3,647 tonnes CO_2 equivalent (tCO_2e), with emissions resulting from products being taken on to aircraft representing the largest contributing factor with a total of 1,373tCO_2e, or 37% of total WDFG emissions. This was followed closely by in store energy emissions at 1,230 tCO_2e or 35% of the total. As these two sources combined account for some 72% of all retailer activities, they are clearly the two that provide the greatest potential in terms of delivering carbon reductions. Staff travel and product distribution represent the only other significant emissions sources at 19% and 10% respectively. By comparison, business travel, waste and water contributed just 5tCO_2e (0.13% of emissions) combined.

Table 6-3; Results of the carbon inventory performed for WDFG activities occurring at Manchester Airport.

Scope	Emissions Source	tCO2e	Percentage of Total
Scope 1	Product Distribution	246	8
	Sub-Total	***246***	***7***
Scope 2	In-store energy usage	1,128	31
	Sub-Total	***1,128***	***31***
Scope 3	Product Delivery (Well To Tank)	54	Less than 1
	Water	2	Less than 1
	Waste	2	Less than 1
	Business Travel	3	Less than 1
	Energy Use (Transport & Distribution)	13	Less than 1
	Energy Use (Well to Tank emissions)	158	4
	Staff Travel	694	19
	Additional Weight on Aircraft	1,373	37
	Sub-Total	***2,300***	***62***
	Total	**3,647**	**100**

It is apparent that Scope 3 emissions are the largest contributor to airport retail systems emissions (predominantly because of products being taken on to aircraft by passengers). Despite WDFG not being directly responsible for these indirect emissions, they contribute over 60% of the company’s carbon inventory at Manchester Airport. This potentially raises questions as to whether WDFG can claim corporate citizenship whilst ignoring emissions that represent significantly more than Scope 1 and 2 emissions combined, simply by suggesting they are someone else's problem – a question that will be discussed in more detail in Chapter 7.

6.4.2 Emissions quantification: on-the-ground sources

6.4.2.1 Energy

The operation of WDFG outlets at Manchester Airport resulted in a total of 1,230tCO_2e emissions during the 12-month reporting period, split across the three Manchester Airport terminals as shown in Table 6-4. Terminal 1 was the predominant source contributor – representing almost 60% of terminal emissions. Well-to-Tank emissions (i.e. emissions that result from the extraction, transport and manufacture of fuels to the point of use by WDFG) contributed an additional 158 tonnes CO_2e to energy emissions – an additional 12.3% of emissions.

Table 6-4: WDFG energy usage and calculated carbon emissions associated with WDFG outlets in each Manchester Airport terminal.

	Terminal 1	**Terminal 2**	**Terminal 3**	**Totals**
Energy Use (kWh total)	129,7267	795,373	208,363	2,301,003
DEFRA Conversion Factor (kgCO_2e/kWh)	0.49023	0.49023	0.49023	
Energy Use Carbon Emissions (kg CO_2e)	635,959	389,916	102,146	1,128,021
Energy Use Carbon Emissions (tCO_2e)	636	390	102	***1,128***
DEFRA Well to Tank Conversion Factor (kgCO_2e/kWh)	0.06888	0.06888	0.06888	
Well to Tank (kgCO_2e)	89,356	54,785	14,352	158,493
Well to Tank (tCO_2e)	89	55	14	***158***
DEFRA Distribution and Transport Conversion Factor (kgCO_2e/kWh)	0.00569	0.00569	0.00569	
Distribution and Transport (kgCO_2e)	7,381	4,526	1,186	13,093
Distribution and Transport (tCO_2e)	7	4	1	12
Total (tCO_2e)			***13***	
All Terminals Total (tCO_2e)	***7,323***	***449***	***118***	***1,230***
Percentage of Total Emissions	***56%***	***35%***	***9%***	***100%***

To calculate the CO_2e emissions associated with operations in of each of the Terminals, WDFG provided energy usage figures going back to 2012 measured as kilowatt-hours (kWh). From this, the research used the most recent 12 month period of reported data (October 2013 - September2014) to ensure that full years' worth of energy use were captured in the calculations. CO_2e totals for in-store energy use were calculated by multiplying the KWh consumed at each terminal by the UK standard carbon conversion factor provided by DEFRA (2015).

The energy use included in these calculations pertains to lighting and air conditioning systems but not heating. The airport operator provides heating to WDFG through its internal, airport-wide heating system. As such, the airport does not directly charge the retailer for this heat; rather it is included as part of the rent the retailer must pay the operator. Accordingly, there is no way for WDFG to calculate the emissions that result from this source and it should be noted that this has the potential to increase company Scope 1 and 2 emissions considerably.

Comparing the energy usage from WDFG activities at Manchester Airport, to the airports overall energy emissions of 19,000 tCO_2 (MAG, 2014) demonstrates that WDFG contribute 6.8% of energy emissions to the entire airport (a figure that would be higher if all heating costs were captured in these calculations).

6.4.2.2 Water

This research has shown that water usage at Manchester Airport by WDFG resulted in an estimated 2tCO2e emitted during the reporting period, as shown in Table 6-5.

Table 6-5; WDFG emissions from Water Usage and Treatment

Terminal	Charges (GBP)	Unit Price (£/m3)[68]	Volume of Water Used (m3)	DEFRA Carbon Conversion Factor (CO_2e/m3)	Water Use Total CO2e	Total Treatment[69]	DEFRA Carbon Conversion Factor (kCO_2e/m3)	Water Treatment Total (tCO_2e)	Total CO_2e (tonnes)
T1	£3,168	2.88	1100	0.344	378.4	1045	0.708	739.86	1.12
T2	£2,519	2.88	874.65	0.344	300.88	830.92	0.708	588.30	0.89
T3	£460	2.88	159.72	0.344	54.94	151.74	0.708	107.43	0.16
Total	**£6,147**		**2134**		**734**			**1436**	**2**

No direct measure of water used in each terminal by WDFG was available to calculate these figures. WDFG were able however to provide water charges made to them by the airport. The airport was not able to provide a price per unit of water used, however the researcher was able to obtain a unit-charging price for Stansted

68 Unit Price for Stanstead Airport (owned by Manchester Airport Group, with WDFG Retail concessions). Assumed same rate at Manchester Airport.

69 Assumption that 95% of water is returned for treatment (based on discussion with the WDFG Health, Safety and Environment Manager and Manchester Replenishment Manager).

Airport (part of Manchester Airport Group – the owning company of Manchester Airport) and applied this to the data, to provide a proxy calculation for water use in cubic metres. The researcher then converted this information into CO_2e by using the DEFRA conversion figures for water use and treatment – with an assumption made that 95% of water used is returned as sewerage requiring treatment.

To provide assurance to these figures, the researcher conducted materiality analysis by modifying the unit price per m3 (see Appendix A). The difference between a unit price of £2/m3 and £3.50/m3 represents 1.3tCO_2e per annum– or only 0.03% of total WDFG carbon emissions for the airport.

6.4.2.3 Waste

The carbon footprint of managing waste produced by WDFG at Manchester Airport totalled 2.3 tCO_2e in the reporting period, as shown in Table 6-6. Waste figures from WDFG activities in the airport were difficult to calculate because they are currently unmonitored by the organisation at a Terminal level. WDFG collect waste daily from the terminals stores they operate across the United Kingdom on a daily basis return it to their central distribution centre for recycling. Non-recyclable waste is incinerated to provide energy for the distribution warehouse. Because of these initiatives, WDFG currently send zero waste to landfill from all their retailing sites in the UK.

Table 6-6; Carbon emissions resulting from the management of waste produced by WDFG operations at Manchester Airport.

	Total Volume WDFG Waste produced at UK Airports (tonnes)	Manchester Airport WDFG Waste (tonnes)[70]	DEFRA Conversion Factor for recycled waste (kgCO_2e/tonne)	Total (tCO_2e)
Cardboard	1045	101	21	2.12
Plastic	30	3	21	0.06
Printer Cartridges	1	Less than 1	21	0.00
Wood	0	0	21	0.00
Metal	10	1	21	0.02
Electrical	0	0	21	0.00
Waste to energy	48	5	21	0.10

70 Assumes waste is proportional to passenger numbers. Manchester is responsible for 9.65% of passengers where WDFG operate in the UK.

Total	**1134**	**109**		**2.3**

In the case of recyclable waste, figures for Manchester Airport were obtainable by making assumptions based on the total waste collected centrally by WDFG for all sites. Passenger numbers at each airport where WDFG operate were used as a proxy by which to estimate the amount waste produced at each site; resulting a figure of 9.65% of total company waste being attributable to Manchester Airport. This is some 109 tonnes of waste annually, spread across a number of different materials. With this information, it was possible to apply DEFRA conversion figures and to obtain equivalent carbon emissions associated with each type of waste. Details of how the researcher accomplished this and the assumptions made in the DEFRA calculations are provided in Appendix B of this thesis.

The result of these assumptions is that there is a high degree of uncertainty associated with this emissions activity. As with water however, materiality analysis (See Appendix C), has shown that increasing the proportion of waste originating from Manchester airport to as high as 25% only increases total carbon by an additional 1.9 tCO_2e.

6.4.2.4 Distribution

Approximately 300 tCO_2e (9% of total) was emitted due to WDFG moving products from their central distribution network to WDFG outlets at Manchester Airport – as shown in Table 6-7, 18% of emissions from this activity can be attributed to Scope 3 emissions that arise in the extraction, product and transportation of fuel for use in WDFG vehicles.

These figures were calculated from the total distance travelled by WDFG vehicles in relation to Manchester Airport activities, and by applying appropriate DEFRA Conversion factors. These figures also include the movement of goods between Manchester Airport terminals on a smaller transit vehicle, to ensure that all vehicle movements where captured.

Table 6-7; Carbon emissions resulting from the distribution of products from the WDFG Central Distribution Centre to Manchester Airport.[71]	
DELIVERIES TO THE AIRPORT	
Daily Deliveries	1
Total Deliveries per Year	365
Ave round trip daily distance (miles)	400
Total Annual Distance (miles)	146000
DEFRA Carbon Conversion Factor (kgCO2e/mile)	1.681832
Total Direct Emissions (tCO2e)	***245***
DEFRA WTT Carbon conversation (kgCO2e/mile)	0.367202
Total WTT Emissions (tCO2e)	***54***
Total Delivery Emissions (tCO2e)	***299***
AIRSIDE MOVEMENTS	
Distance per day (miles)	2
Annual Distance (miles)	730
DEFRA Carbon Conversion Factor (kgCO2e/mile)	0.402319278
Total Direct Emissions (tCO2e)	***0.29***
DEFRA WTT Carbon Emissions (kgCO2e/mile)	0.087837996
Total WTT Emissions (tCO2e)	***0.06***
Total Airside Carbon (tCO2e)	***0.35***
Total Deliveries emissions tCO2e	**300**
Total Scope 1 Emissions (tCO_2e)	**246**
Total Scope 1 Emissions as percentage of total	**82%**
Total Scope 3 Emissions (tCO_2e)	**54**
Total Scope 3 Emissions as percentage of total	**18%**

These figures are relatively robust. The researcher obtained data on the number of daily deliveries made to the airport through discussion with the WDFG Replenishment Manager at Manchester Airport, who oversees such deliveries. Distance travelled was calculated by using departure and destination postcodes with the optimal route identified through Google Maps[72]. The specific vehicles used by the company for distribution were identified and given appropriate DEFRA conversion factors for diesel vehicles (see Appendix). The main assumption in this analysis involved the mileage covered by airside movements by the company's

71 Vehicle movements based on discussions with WDFG HSE Manager, and Manchester Replenishment Manager.
72 https://maps.google.co.uk

airside delivery vehicle. A figure of 2 miles per day was advised by the WDFG Replenishment Manager. It was assumed that vehicles would be 100% laden since the company operates an efficient stocking policy, meaning that delivery vehicles always operate at, or close to maximum capacity. All assumptions within these calculations were well informed through discussion with WDFG staff, and are supported by materiality analysis (see Appendix D) which found that increasing daily mileage by an additional 25 miles would only increase total emissions for this source by 18 tCO_2e.

6.4.2.5 Business travel

Business travel by WDFG employees operating at Manchester Airport resulted in carbon emissions measuring 3.11 tonnes CO_2e (see Table 6-8).Emissions from car travel were the highest contributor to business travel emissions, with an estimated 1.5 tCO_2e per year. Air travel was the other main contributor with emissions of 1.1 tCO_2e, with the remaining transport modes contributing just 15%.

Of all the activities, this required greatest amount of assumptions, as WDFG do not presently monitor business travel. Accordingly, secondary sources were used. Discussions with the WDFG Health, Safety, and Environment Manager identified that five employees at Manchester Airport were likely to go on business travel in a given year. To this, UK Government statistics (DfT, 2011) were applied which showed that individuals who go on business travel typically do so on average 30 times per year, over an average distance of 18 miles. Government statistics also provided the modal split for business travel.

Table 6-8; Business Travel Emissions Arising from WDFG activity at Manchester Airport					
Type of Travel	**Annual Distance Travelled (miles)**				
Site employees travelling on business[73]	5				
Average number of trips per year[74]	30				
Average distance travelled (miles)[75]	100				
Total Distance Travelled per year (miles)	15000				
Mode of Transport	**Percentage of Total Distance (miles)**	**Distance (miles)**	**Conversion Factor ($kgCO_2e/m$)**	**Emissions (tCO_2e)**	**Percentage of Emissions (tCO_2e)**
Car	0.35	5250	0.29341	1.5	49
Foot	0.05	750	0	0	0
Flight[76]	0.25	3750	0.29795	1.11	36
Bus	0.1	1500	0.10033	0.24	8
Train	0.2	3000	0.04505	0.21	7
Bicycle	0.05	750	0	0	0
Total	**100**	**2745**		**3.1**	**100**

Before applying these figures, some modification to the data took place, verified with the WDFG Health, Safety, and Environment Manager. Being based in an airport, and as part of an international organisation, it was agreed more than 6% of business trips (as per national statistics) would be likely to occur via air travel. Likewise, the researcher deemed walking and cycling worthy of a reduction, due to the nature of the airport making ground access difficult, and having relatively good, direct transport links for other modes. It also became apparent that the 30 miles average travelling distance would be insufficient for these calculations in that

73 Based on discussion with WDFG HSE manager and Manchester Airport Replenishment Manager.
74 Assumption based on https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/230553/Commuting_and_business_travel_factsheet___April_2011.pdf
75 Assumption based on this link, but increased to account for airport setting https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/230553/Commuting_and_business_travel_factsheet___April_2011.pdf
76 Short Haul DEFRA conversion figure (assumes that WDFG would typically be travelling in the UK).

business travel could occur on a global scale, or at least to company headquarters at Bedfont Lakes, London. Accordingly, this distance was increased to 100miles per trip. Materiality analysis to assess the robustness of these calculations are provided in Appendix E, which found that increasing to 6 travelling employees, on an average of 50 trips per year increased carbon to 3 to 6 tCO_2e per year. As with the other calculations, this is a small increase compared to the size of energy emissions detailed above (and the impact of products taken on aircraft discussed later in this chapter).

6.4.2.6 Staff commuting

As shown in Table 6-9, emissions resulting from the 333 WDFG employees commuting from their homes to work resulted in total annual emissions of 694 Tonnes CO_2e, with 83% (577 tonnes) of these arising from direct combustion in the engine of the mode of transport used. An additional 117 tCO_2e can be attributed as well-to-tank emissions.

Table 6-9; emissions arising from WDFG staff commuting from Manchester Airport based employees

Mode of Transport	Activity Data (Miles Travelled)[77]	Conversion Factor ($kgCO_2e/m$)	Total Direct Emissions (tCO_2e)	WTT Conversion Factor ($kgCO_2e/m$)	Total WTT Carbon (tCO_2e)	Percentage of Emissions
Car - Large Diesel	254,651	0.36	92	0.078	19.99	16
Car - Large Petrol	472,922	0.46	221	0.09	43.41	38
Car - Medium Diesel	181,893	0.28	51	0.06	11.11	9
Car - Medium Petrol	337,802	0.32	108	0.06	21.24	19
Car (share) - Medium Diesel	72,757	0.28	20	0.06	4.57	4
Car (share) - Medium Petrol	135,120	0.32	43	0.06	8.25	8
Bus	201,452	0.10	32	0.02	7.04	6
Train	100,726	0.045	7	0.008	1.32	1
Run / Walk / Cycle	60,435	0	0	0	0	0
Total	**1,817,761**		**577**		**116.95**	**100**
Combined Direct / Indirect Emissions			**694**			

In total, WDFG employees commuted a total of 2,025,639 miles in the reporting year – an average of 6087 miles per person, with an average distance from the airport of 13.8miles. Car transportation was the overwhelming contributor to these emissions representing 93% over total emissions (645 tCO_2e). The potential

77 SEE APPENDIX F

carbon saving from public transport use is illustrated by the fact whilst that a third of WDFG employees at Manchester Airport do not drive to work, these individuals account for just 7% of staff commuting emissions.

These figures are associated with some uncertainty in that the specific modes of travel for each employee are unknown. The researcher calculated the distances travelled by WDFG employees based on their home addresses and the distance from Manchester Airport (using Google Maps[78] to find the optimal route). The researcher then used data regarding staff transport modes for Manchester Airport (Manchester Airport, 2007), to calculate the likely modes of transport taken by each employee, and thus the distance travelled per mode. This was supplemented by assuming that those employees with a car parking spot would be likely to drive to the airport (see Appendix F). This information was then subjected to the DEFRA conversion factors for different modes of transport. Opportunities for error included a lack of accounting for car sharing and an assumption that distances travelled by those using different modes of transport were the same, when in reality this may not be the case. In light of the fact that this data was simply not available, the researcher believes that the figures produced for staff travel are as robust as they could be; where possible, they are based on actual data, and where this was not possible they are based on informed assumptions from relevant data sources.

78 https://maps.google.co.uk/

6.4.3 Emissions quantification: products taken onto aircraft

As previously mentioned, products purchased at WDFG stores will either be consumed and disposed of in the airport, or will be taken onto aircraft, flown to destination airports, and potentially flown back again if purchased on the outbound leg of a two-way flight. Despite this, a review of the literature and discussion with WDFG found that the fuel burn impacts of this had not previously been calculated. As such, the carbon and fuel cost implications of this additional weight were unknown. This section looks to add to the literature in this regard, by identifying the indirect consequences of the WDFG business model on aircraft fuel burn and therefore carbon emissions.

The approach taken in performing these calculations is summarised in Figure 6-6 below. This phase of the research contains four distinct phases or functions, with a number of inputs (either arising from external sources or through previous functions).

This section describes the calculations carried out in each of these phases in turn. It begins by examining the sales of products by WDFG at Manchester Airport – including a description of how the researcher addressed a number of data quality issues. Following this, appropriate calculation methodologies were identified and tested, with the most suitable selected. The section then applies this methodology to the derived weights data from WDFG to quantify the fuel burn implications for a sample of specific routes at Manchester Airport, before extrapolating these findings to the wider WDFG business, and global duty free industry[79].

79 Extrapolation to the wider airport retailing sector (i.e. beyond duty-free) was not possible with the data provided, however the potential impacts of the wider sector, beyond duty-free, are inferred in the chapter summary.

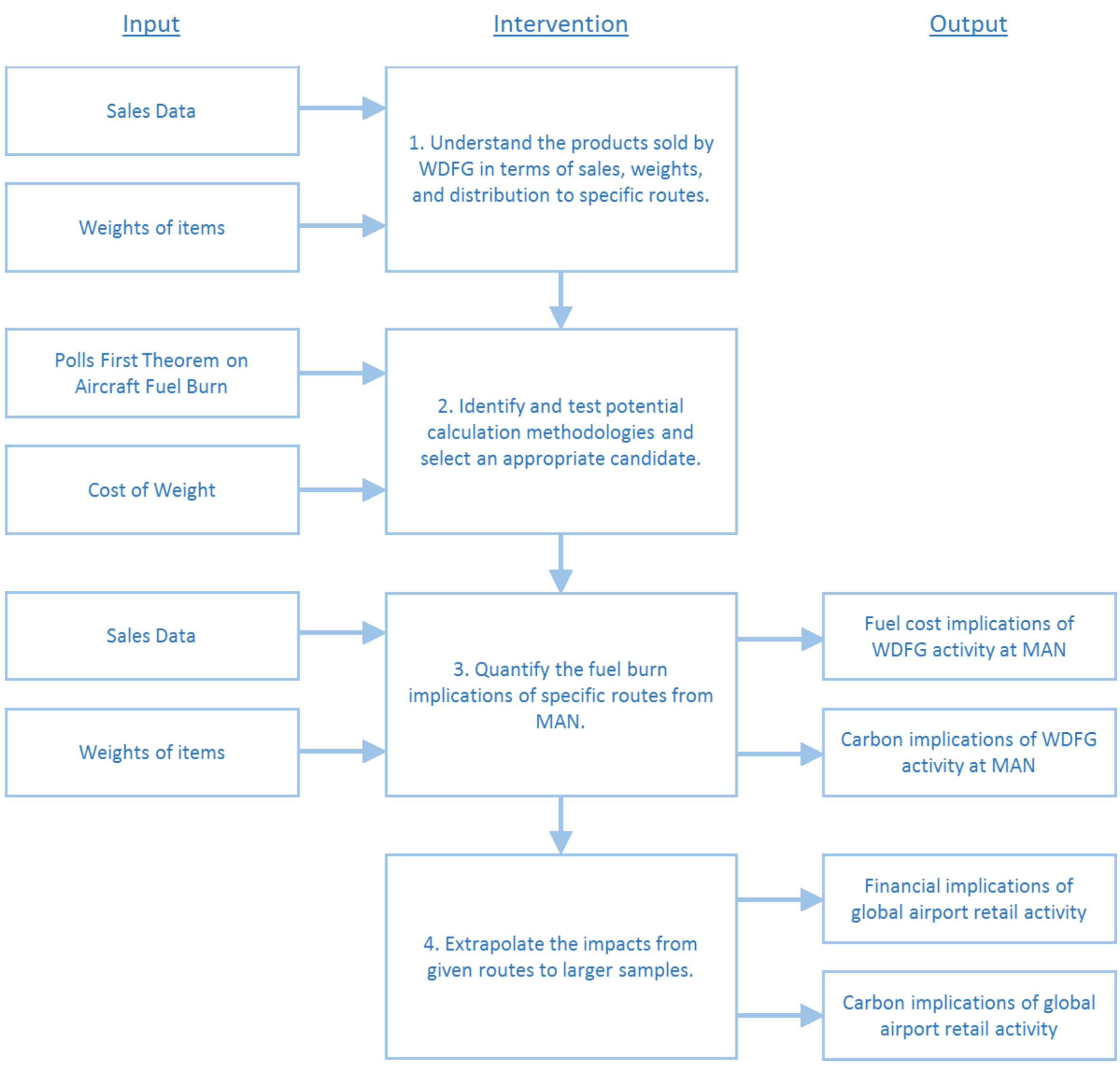

Figure 6-6; The calculation phases in determining carbon and fuel cost implications for the carriage of WDFG products by aircraft. Polls First Theorem and the Cost of Weight Formula are two calculation methodologies that the researcher applied to the data set, as described in Section 6.4.3.2.

6.4.3.1 Analysing the products sold by WDFG and quantification of the weight of materials carried on specific routes

The amount of aircraft traffic on particular routes varies considerably on a daily, monthly and annual basis. Additionally the types of passengers who fly on these aircraft may also differ over time, bringing with them different purchasing habits and attitudes towards airport shopping. This means that the types of products sold by WDFG differs considerably over the course of a year, where they are flown to, and in what quantities. Aware of this the researcher first looked to analyse WDFG sales over a one-year period, with the objective of informing the calculations that would follow.

WDFG provided access to a database holding information on every item sold at Manchester Airport. The 2010 dataset was chosen to match a dataset of aircraft movements for the same period. Upon receipt of this data, it became immediately clear that there existed many gaps with the data set. This included items listed without a weight, or items listed with clearly incorrect values - typically very large weights. As an example, the largest weight in the data set was 58.5kg for a packet of chewing gum. Discussion with WDFG about this revealed historical issues that saw ‘net’ product weight confused with ‘gross’ product weight, the latter referring to the bulk weight of multiple products as they were delivered to WDFG from their suppliers. This would see, for example, the weight of a case of wine listed rather than individual bottles. The researcher carried out this process in a sequential manner, as illustrated in Figure 6-7, to ensure calculations would be, as far as possible, based on real-world data. For example, the trimmed mean figure was only applied where there was no alternative way in which the product weight could be calculated. Details of any errors in the weights database, and how the researcher resolved these, are summarised in Table 6-10. Whilst the number of products that required intervention by the researcher was small, and the described methodology provides assurance that intervention was justified, it should be stressed the figures will not be 100% accurate.

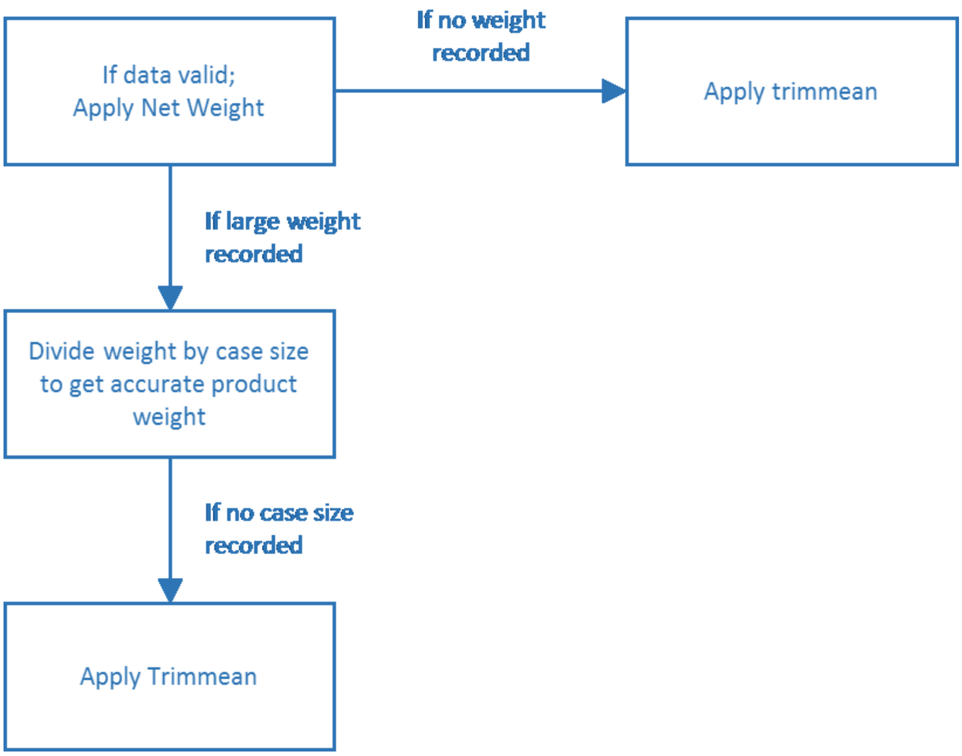

Figure 6-7; illustrating the sequence through which, the researcher dealt with errors in the WDFG dataset.

Table 6-10: The process by which, the researcher dealt with errors in the WDFG dataset.			
Issue	Instances	As Percentage	Approach by the researcher
No error	15605	70	These figures accepted by the researcher.
Products with no net or gross weight	5025	22	A Trimmed-mean[80] was applied to each product category by removing the top and bottom 10% of category weights, taking the average of the remainder, and applying this to those weights with Zero values.
Products with bulk delivery rather than single item weights	1542	7	Where case sizes were provided in the data set, the gross weight was divided by case size to produce individual item weights. This was extensively sense tested to ensure that no erroneous values remained.
Products with particularly high weights	256	1	In instances where case size equalled 1 (the minimum in the data set), and no division of gross weight could take place, the trimmed mean for was applied.

6.4.3.1.1 Product categories, sales and weights

Table 6-11 illustrates how 3,426,742 individual items, spread over 22,428 different products, and 24 product categories were sold by WDFG at Manchester Airport in the sample data provided. Almost 70% of shoppers purchased just one item. Of these product categories Fragrance and Spirits were the most popular, each representing some 20% of all item sales, followed by Cosmetics at 15% of sales.

Of these categories, Champagne (1.88kg), Spirits (1.77kg) and Wines (1.38kg) represent the heaviest items sold in terms of average weight, per product type. The most popular product department of fragrance had an average weight of 0.3kg – slightly below the overall average product weight of 0.44kg. As illustrated in Table 6-11 above, Spirits represent the category of most weight sold - 1,055 tonnes, or 51% of total weight sold. This is some way ahead of fragrance, which despite being the most popular item sold, accounts for just 216 tonnes, or 10.5% of weight sold. The fact that average item weight per category vary considerably across the product brands suggests that product weight will play an important role in the results of this chapter, and that significant aircraft fuel burn savings may be possible by focusing on a small number of product categories.

80 The calculation of the mean after discarding given parts of a sample at the high and low end, and typically discarding an equal amount of both.

Table 6-11; Product Categories sold by WDFG by weight and sales volume.					
Product Category	**Total Number of Items**	**Sales as Percentage of total**	**Average Weight (kg)**	**Tonnes Weight sold**	**Weight as percentage total weight**
Spirits	683073	20	1.77	1056	51
Fragrance	708233	21	0.30	217	10
Cosmetics	517061	15	0.37	190	9
Confectionery	330168	10	0.32	114	6
Cigarettes	213378	6	0.44	107	5
Wines	62423	2	1.38	89	4
Champagne	34960	1	1.88	74	4
Delicatessen	235600	7	0.31	73	4
General	167823	5	0.19	32	2
Loose Tobacco	39434	1	0.34	16	1
Watches	52572	2	0.27	14	1
Toiletries	54916	2	0.33	14	1
New Fashion	36329	1	0.47	14	1
Souvenirs	50819	1	0.28	12	1
Jewellery	58233	2	0.19	11	1
Travel Essentials	50299	1	0.23	11	1
Games and Toys	51027	1	0.19	10	Less than 1
Sunglasses	47601	1	0.19	9	Less than 1
Fortified Wines	9755	Less than 1	0.31	3	Less than 1
Machine Made Cigars	15054	Less than 1	0.10	2	Less than 1
Electricals	2038	Less than 1	0.31	Less than 1	Less than 1
Hand Made Cigars	2731	Less than 1	0.19	Less than 1	Less than 1
Smokers Accessories	3169	Less than 1	0.07	Less than 1	Less than 1
Optical	46	Less than 1	0.09	Less than 1	Less than 1
Totals	**3,426,742**	**100**		**2068**	**100**

6.4.3.1.2 Fluctuation of sales over time

WDFG sales peak in the summer months, largely due to increased sales of fragrance, cosmetics and spirits (see Figure 6-8). This can be explained by the increase in passenger numbers at the airport during these months, as illustrated in Figure 6-9.

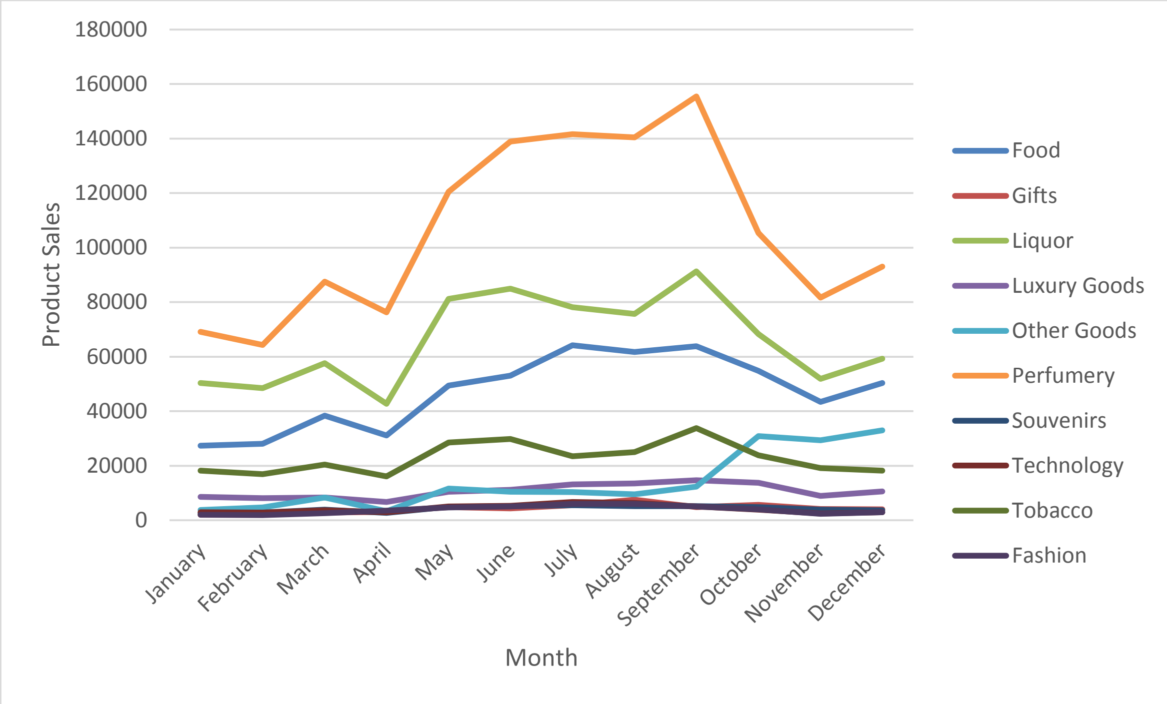

Figure 6-8; monthly variation in sales per product category.

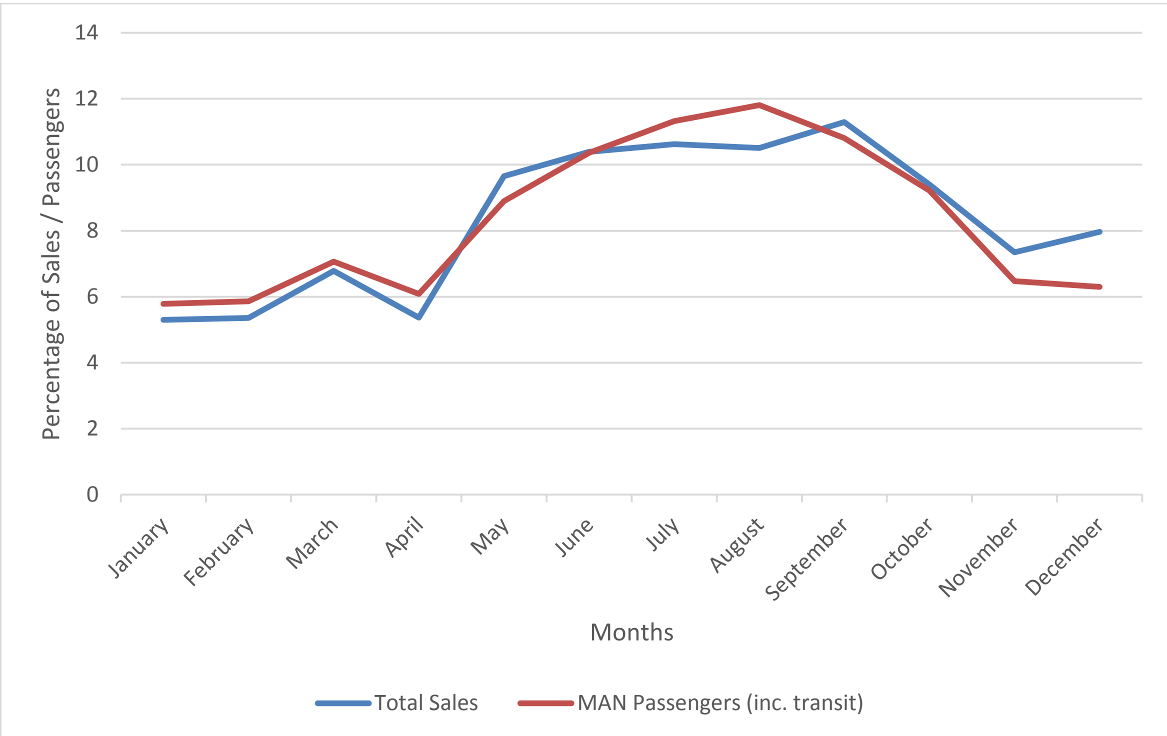

Figure 6-9; Number of monthly WDFG sales compared to Manchester Airport passenger numbers. Here it can be seen how there is a clear correlation between the two.

The majority of this growth in sales was for passengers travelling to European destinations (Figure 6-10). WDFG confirmed that this is due to an increase in passengers to holiday destinations who are seeking products that they may use on holiday. The data showed that Perfumery, and Liquor, and to a lesser extent food, are the predominant drivers of these increases.

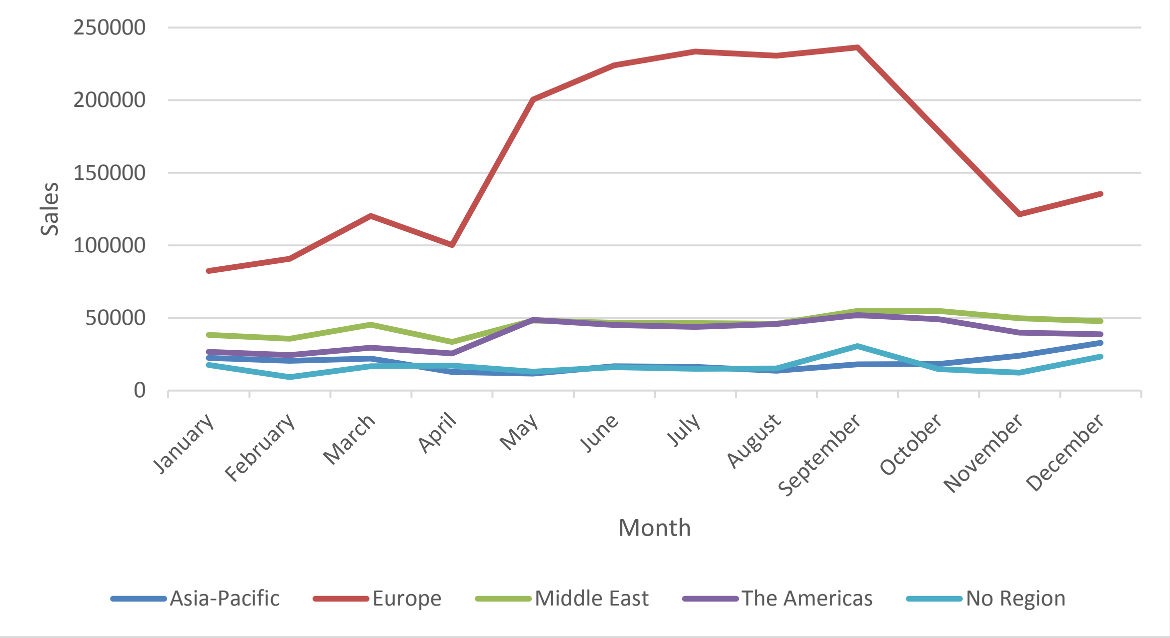

Figure 6-10; Monthly sales by region products flown to. No region denotes arrivals or staff purchases.

In terms of the calculations to follow, this suggests that figures used should be for an entire year's worth of data, to account for any seasonal fluctuations.

6.4.3.1.3 Destination analysis

Products sold by WDFG at Manchester were for passengers travelling to 925 airport destinations, located in 181 nations, or some 92% of all nations globally[81]. As presented in Table 6-12, the majority of these destinations see only small number of sales, with the top 30 countries representing 88% of all items flown. Dalaman Airport, Turkey, was the most popular destination by sales, representing some 5.6% of all items sold. In terms of weight, the picture is similar, with the top 30 airports representing 52% of all weight purchased by WDFG passengers. Dalaman airport in Turkey was again the main contributor to this, representing 8.15% of WDFG item weight purchased. This is almost double the amount of weight for Sharm el-Sheik in second place (4.64%), and Tenerife in third at 3.53%.

81 Based on 196 nations globally - http://www.un.org/en/members/

The profile of products sold to passengers to a given destination can have a marked impact on the total amount of weight flown. For example, Stockholm Airport is ranked 37th in terms of number of products sold, but is 5th in terms of total weight purchased by passengers. Clearly it is not just the volume of sales that has an impact on total weight, but a combination of volume sales, and the weight thereof – both of which having the potential to have a marked impact on the amount of weight flown.

Table 6-12; Destinations WDFG products were flown to after being purchased, by sales volume and weight

Airport	Weight (kg)	Sales volume	Rank Weight	Rank Sales	Weight as Percentage of total	Sales As Percentage of total
Dalaman	168683	192973	1	1	8%	6%
Sharm El Sheikh	95998	144678	2	2	5%	4%
Tenerife	73088	108281	3	4	4%	3%
Bodrum	65590	75219	4	8	3%	2%
Arrivals Airport	58285	63885	5	9	3%	2 %
Dublin	48482	84059	6	5	2%	2 %
Orlando	46664	76351	7	7	2%	2 %
Dubai	43923	83783	8	6	2%	2%
Staff Sales Airport	42824	136317	9	3	2%	4%
Antalya	39506	54072	10	12	2%	2%
Arrecife	34834	55811	11	11	2%	2%
Monastir	32464	40692	12	18	2%	1%
Larnaca	27488	57181	13	10	1%	1%
Toronto	26999	32864	14	26	1%	1%
Stockholm	25510	27617	15	37	1%	1%
Copenhagen	24333	35397	16	20	1%	1%
Barbados	23772	34176	17	23	1%	1%
Hurghada	23675	32928	18	25	1%	1%
Paphos	23638	50049	19	13	1%	1%
Zurich	23546	35092	20	21	1%	1%
Las Palmas	21907	33725	21	24	1%	1%
Palma De Mallorca	21333	48024	22	14	1%	1%
New York	21234	38454	23	19	1%	1%
Alicante	20885	44045	24	16	1%	1%
Cancun	20751	43075	25	17	1%	1%
Malaga	20616	44555	26	15	1%	1%
Geneva	18567	25009	27	44	1%	1%
Helsinki	18367	28933	28	34	1%	1%
Luxor	18085	22899	29	48	1%	1%
Fuerteventura	17889	28893	30	35	1%	1%

The researcher excluded sales of products to WDFG staff and products collected at the airport on arrival from the calculations, as it is unlikely that these would be taken onto aircraft. Doing so reduced total weight flown by 58 and 43 tonnes respectively reducing the total weight of WDFG sales at Manchester that were assumed to have been taken onto aircraft to 1,968 tonnes annually.

All of the above suggests that it may be possible, when wishing to calculate the overall impact of products sold by WDFG on airline fuel burn and carbon emissions, to do so by focusing on only a small number of destinations that are likely to be responsible for the majority of such impacts. Furthermore, from an analytical perspective, this suggests that activities designed to reduce emissions and fuel burn from WDFG products being taken on to aircraft could be prioritised on only a small number of routes, for example a collection on arrival offer at Dalaman Airport could reduce carbon impacts significantly.

It is noteworthy that the dataset only includes the final destination to which passengers carried products. The exact route taken, potentially with multiple stops, is not recorded in the WDFG dataset. This has implications for calculating fuel burn, however materiality analysis (see Appendix I), has shown that increasing total fuel burn in these calculations by as much as 50% results in a negligible difference to the sectors contribution to global aircraft emissions or fuel burn.

6.4.3.1.4 Summary of initial observations

Combining the above analysis with the results of previous research phases enabled the research to make a number of observations:

- Data provided by WDFG is relatively robust as it includes the weight and destination flown of every item sold from their operations at Manchester Airport.
- The data do not provide specific routings for every destination. Nor does it include whether items were consumed and disposed of before boarding flights, or whether they were carried back on return flights.
- WDFG sales are largely dependent on passenger numbers, and these vary through the year in terms of sales volume, and the nature of destinations

visited. Passenger types (and corresponding propensities to buy particular products) also differ over time[82].

- Because of these factors, different routes have different sales and weight profiles and these fluctuate over time.
- The fact that a small number of destinations from Manchester represent a large amount of weight purchased, indicates that these routes may act as a useful proxy in performing these calculations, particularly as these airports represent a range of different distances.

Based on these observations it was decided to initially test the calculation methods used in this section on the top 30 destinations of WDFG item sales, by weight flown. Not only do these destinations represent over 50% of weight flown, they cover a range of destinations globally, and flight lengths.

6.4.3.2 Selection of the method for calculating the implications of weight for aircraft fuel use and emissions.

The removal of weight from an aircraft has a direct impact on fuel burned during a flight and therefore carbon emissions (Mason and Miyoshi, 2009). Through the literature review, the researcher identified two methodologies for potential use in this research, that were robust enough to be of academic value, without being overly complex, or requiring data input that might be unobtainable to the researcher. Accordingly, each methodology was tested to establish the complexity of the calculation in relation to the level of accuracy required, to establish a relevant sample size required, and ultimately to determine which would be most appropriate for use in this research project. These two distinctly different methodologies are introduced in turn below.

6.4.3.2.1 Calculation method one; Cost of Weight Factor.

This calculation is based on a methodology adopted by the International Air Transport Association (IATA 2011) that states that additional fuel burn per hour is the equivalent of 3% of additional weight carried – known in the literature as Cost

82 For example, volume and weight of sales differ between business and leisure passengers and, between nationalities and for different destinations.

of Weight Factor (COW) (AITO,2012). So for a 4-hour flight carrying an additional 20kg of weight;

$$\boldsymbol{Additional\ fuel\ burn = (Additional\ weight\ x\ weight\ factor)\ x\ flight\ hours}$$

$$\boldsymbol{(20kg.0.03) * 4 = 2.4kg\ additional\ fuel\ burn}$$

This calculation is used by airlines and aircraft manufacturers, including for example; Brussels Airlines (P. Steurbaut, 2014, person. comm., 24th November), and British Airways (Morris, 2006), Boeing (Boeing, 2011) and Bombardier Aerospace (Viscotchi, 2006); it is therefore a widely accepted, tried and tested approach that is independent of aircraft type, and comparatively straight forward to apply. As such, the researcher considered this an appropriate tool for consideration.

The COW Formula (see AITO, 2012) states that the cost of additional weight carried by an aircraft ranges from 3.15% to 3.4% for flights between 1 and 10 hours, as illustrated in Figure 6-11 below – slightly higher than the 3% figure used in industry.

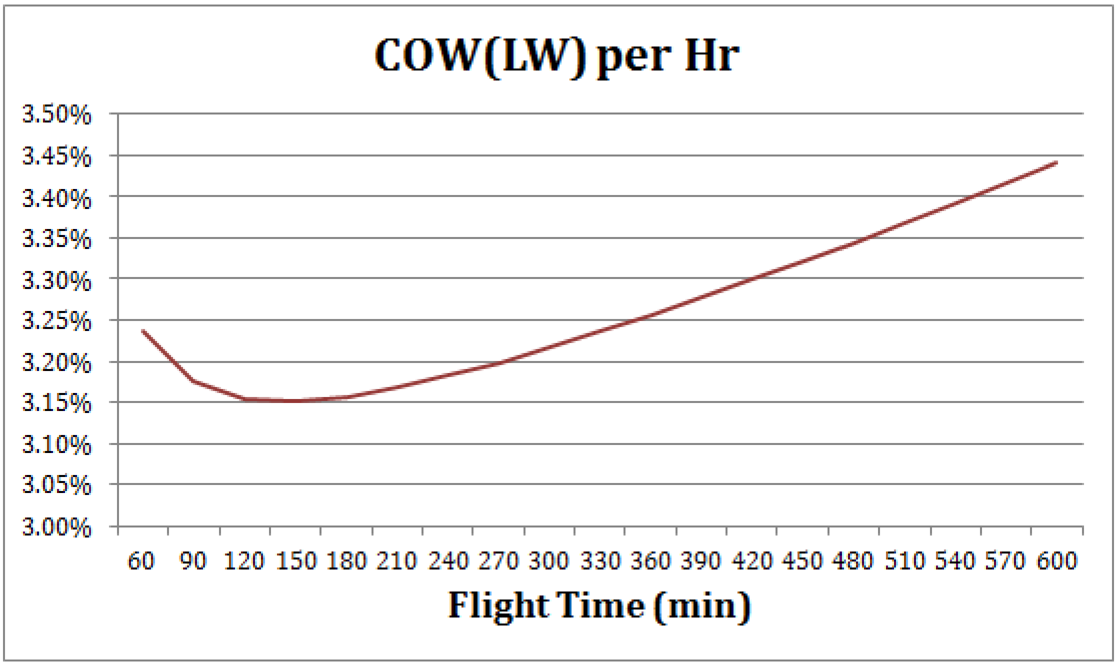

Figure 6-11; The COW Formula states that the additional fuel burn per flight hour of additional weight carried is typically in the range 3-3.5%.

Accordingly, the researcher conducted materiality analysis by altering the percentage figure used in the calculation to 3%, 3.5% and 4% additional fuel burn per flight hour. This resulted in only minor changes in the results of the method testing (see Appendix I). That a figure of 3% was found to be widely cited in industry, combined with the fact that materiality analysis resulted in minimal changes to the application of this calculation, suggested to the researcher that the 3% figure would be appropriate on which to test the method. The researcher was able to apply weight figures from the WDFG data set to in the testing of this method, whilst average flight times per route were obtained from an unpublished industry data set provided by Dr. Ling Lim of Manchester Metropolitan University. It should be noted that this data set does not include changes to flight times because of wind conditions, or actual routing of each aircraft, however obtaining such level of data for such a large dataset was not possible. As such, the researcher believes that the approach taken remain an appropriate proxy.

6.4.3.2.2 Calculation method two; Polls first theorem.

The second methodology that could be used to calculate the impact of WDFG items being taken onto aircraft was Polls First Theorem (Poll, 2009), an approach that is independent of aircraft type, and can be used to estimate the fuel saving per sector for a given weight saving (Mason and Miyoshi, 2009).

Polls theorem states that:

$$\frac{dMMF}{MMF} = \frac{d(MZF + MFnc)}{(MZF + MFnc)}$$

Where:

MMF = Mass Mission Fuel

MZF = Mass Zero Fuel. Where:

MZF = OEM + *MP* where:

OEM = Operational Empty Mass[83]

MP = Mass of Payload. Where:

MP = Passenger Weight (inc. baggage) + Cargo

MFnc = Mass Fuel not consumed. Where:

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83 Weight of the aircraft before loading of fuels, liquids, cargo, passengers, luggage etc.

MFnc = MFRes + MFTank

MFTank = Tankered Fuel[84]

MFRes = Reserve Fuel[85]. JAA[86] rules are that the minimum reserve fuel should be 4.8% of the MTO (Mason, 2009). Where:

MTO = Mass at Take Off

MTO = MZF + MMF + MFnc

This theorem works on the premise that if the mass of the aircraft is changed in anyway, the percentage change in the fuel burned to carry out the flight is equal to the percentage change in the sum of an aircraft's zero fuel mass, and the fuel carried, but not burned (Poll, 2008). From a data input perspective, this means that the researcher does not need to input information regarding engine efficiencies, flight paths, weather conditions and so forth, rather, it is based exclusively on weights.

This approach does require a number of assumptions to be made, however these can be obtained from sources that lend confidence to its use, for example average passenger numbers per flight, estimated distance flown (assuming perfect routing, with zero impacting weather conditions), and according to the Great Circle Distance[87] between the point of departure and arrival. Using assumptions in this way is both common with standard carbon accounting (see the previous calculations regarding WDFG on-the-ground emissions), and additionally in the calculations of aircraft emissions. An example of this is the ICAO carbon calculator[88], an on-line tool to calculate carbon attributed to a passenger for a given flight between two destinations. This calculator is built around a robust methodology (ICAO, 2014), which includes a number of assumptions, namely; great circle distance, representative aircraft, cabin class, passenger load, and passenger to cargo load factor. Accordingly, it was necessary for the researcher to identify which components of Poll's first theorem could be accurately obtained, and which would rely on assumptions. Table 6-13 below illustrates how the researcher went about this process.

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84 Fuel carried but not burned.
85 Fuel carried for use in emergencies that is not expected to be used on a typical flight.
86 Joint Aviation Authority (https://jaato.com/)
87 The shortest distance between two points on the surface of a sphere
88 http://www.icao.int/environmental-protection/CarbonOffset/Pages/default.aspx

Table 6-13; Data sources for performing calculations using Poll's First Theorem.	
Data Requirement	Data Source
Aircraft Type	ICAO Carbon Calculator
Mass of Payload	Number of seats (unpublished industry data provided by Dr Ling Lim, MMU) multiplied by 100kg (as per ICAO Carbon Calculator)
Mass Mission fuel	ICAO Carbon Calculator
Operational Empty Mass	Unpublished Industry Data Provided by Dr Keith Mason, Cranfield University.
Tankered Fuel[89]	4% of mission fuel (K Mason 2015, pers. comm., 21st January)
Reserve Fuel	JAA rules state minimum reserve fuel should be 4.8% of MTO (Mason, 2009)
Cargo	Unobtainable. Assumed 600kg per flight[90]

6.4.3.3 Calculation method testing and selection

The researcher tested the suitability of each methodology on a sample of the top 30 destination airports by total weight sold, representing almost 55% of all weight taken onto aircraft because of sales of WDFG products at Manchester airport.

As detailed in Table 6-14 below, applying the two different calculation methods to the case study sample set of data delivered results that were relatively similar to each other, with only a few destinations significantly apart. This provides confidence to the researcher that the both methodologies are likely to be robust enough for use in this research.

Considering the fact that the COW Formula is widely used in industry, and is a less time intensive methodology, the research deemed it the most appropriate for use in the present research.

Once the decision was made to use the COW Formula method, the analysis was repeated for a larger sample of the top 200 destinations to which items sold by WDFG were likely to be flown. This decision was made on the fact that this sample represented 97% of all weight sold by WDFG at Manchester Airport (despite representing just 21% of destination airports), with the remaining destinations contributing less than 0.05% of the total weight on a destination-by-destination basis. This gave the researcher confidence that performing the calculations on this

89 Where aircraft may carry more fuel than is required for a flight, typically due to different fuel costs in different locations.
90 Based on annual freight of 95,696 tonnes, and 168,135 annual movements at Manchester Airport.

sample of flights only would provide an adequate sample size on which the impact of WDFG items being taken onto aircraft could be understood. Not only does the sample capture the majority of weight sold, it would also be possible to extrapolate the figures up to 100% of weight sold – on the assumption that the remaining flights shared a similar flight profile.

Table 6-14; illustrating the results of the methodology testing exercise utilising Polls First Theorem, and The COW Formula to calculate additional carbon emissions from WDFG products being taken onto aircraft and flown to the 30 most popular destinations (by weight of products sold).		
	Additional kgCO_2e per flight as a result of WDFG sales	
Destination	Polls First Theorem	Cost of Weight
Dalaman	41.2	41.3
Sharm El Sheikh	49.0	48.6
Tenerife	24.4	19.5
Bodrum	31.5	36.7
Dublin	2.2	1.8
Orlando	47.2	60.7
Dubai	10.8	17.2
Antalya	47.4	26.5
Arrecife	17.9	14.4
Monastir	58.5	29.7
Larnaca	21.8	15.0
Toronto	40.9	30.6
Stockholm	11.7	7.3
Copenhagen	4.9	4.4
Barbados	50.9	59.6
Hurghada	56.1	54.0
Paphos	16.3	12.3
Zurich	3.7	3.3
Las Palmas	25.7	19.3
Palma De Mallorca	4.2	4.5
New York/Newark Nj Apt	38.4	22.1
Alicante	5.7	4.8
Cancun	93.0	68.5
Malaga	6.0	5.0
Geneva	4.8	4.1
Helsinki	6.4	5.2
Luxor	55.8	63.5
Fuerteventura	20.9	15.6
Philadelphia	36.7	37.0
Total kgCO_2e	**733**	**834**

6.4.3.4 Quantification of the fuel burn implications of specific routes and extrapolation.

As detailed in Appendix H and summarised in Table 6-15 below, the fuel burn implications of WDFG products in the sample data set being sold at Manchester Airport was calculated as an additional 285 tonnes per year. This figure was subjected to a number of extrapolation processes to identify the total fuel burn of all WDFG sales in the reporting period, and to infer the likely scale of additional fuel burn as a result of the duty and tax-free industry, on a global level – i.e. to account for the entire sector.

Table 6-15; Summarising the extrapolated impacts of fuel cost and CO_2 as a result of products sold from duty-free outlets being taken onto aircraft.	
FUEL BURN	
Additional Fuel burn in the data set (tonnes)	284.87
Percentage of total weight accounted for in the sample	97%
Additional Fuel burn grossed up to 100% of weight (tonnes)	292.98
Additional Fuel per Passenger (tonnes)[91]	0.00002
Additional Fuel burn in 2014 (tonnes)[92]	**361.53**

To provide figures that account for all sales made by WDFG in the reporting period, the sample size of 97.2% of ‘weight’ sold by the company, was grossed up to account for 100% of ‘weight’ sold by the company, on the assumption that the remaining flights would have a similar flight profile to those captured in the sample. Whilst this is not necessarily the case, the fact that only 2.8% of weight was unaccounted for in the original data sample means that any discrepancies between actual emissions should be negligible.

Finally, the researcher sought to take into account the fact that the data set provided was for the year 2010. In the intervening years, Manchester Airport has grown from 17,873,188 to 22,055,258 passengers per year. Based on the assumption that passenger purchasing habits (weight bought per passenger) remained constant during this period, the researcher extrapolated weight of items sold to account for passenger growth by calculating ‘weight purchased’ per passenger in the 2010 data set, and multiplying this by 2014 traffic numbers. This

91 Based on 17,873,188 passengers in 2010 (MAG, 2015)
92 Based on 22,055,258 passengers in 2014 (MAG, 2015)

saw the final amount of additional fuel burn resulting from WDFG activities at Manchester Airport be calculated as 362 tonnes per year.

6.4.3.5 Calculating the carbon and fuel cost implications of additional fuel burn.

The final stage of this quantification process involved taking the additional fuel burn figures described above, and calculating the corresponding fuel costs and carbon emissions. As shown in Table 6-16 below, to estimate the carbon impacts resulting from WDFG sales being taken onto aircraft, the researcher multiplied additional fuel burn by DEFRA derived carbon conversion factors for the direct burning of fuel by aircraft. Additionally, a carbon conversion factor was applied for those emissions brought about by the extraction and transport of fuel to point of use. This resulted in 1,138.72 and 234.74 tCO_2e respectively – a total of 1,373.47 tCO_2e for the airport. By calculating the additional fuel burn per passenger (0.00008tCO_2e/person) and multiplying this by the number of global airport passengers (3,100,000,000 – ATAG, 2015) the researcher was able to calculate the approximate global emissions that result from the duty and tax-free retail sector. This represents 238,220tCO_2e globally – or 0.03% of global emissions from aircraft.

Table 6-16; Summarising the extrapolated impacts of fuel cost and CO_2 as a result of products sold from duty-free outlets being taken onto aircraft.	
FUEL BURN	
Additional Fuel burn in the data set (tonnes)	284.87
Percentage of total weight accounted for in the sample	97%
Additional Fuel burn grossed up to 100% of weight (tonnes)	292.98
Additional Fuel per Passenger[93]	0.00002
Additional Fuel burn in 2014[94]	**361.53**
CARBON	
DEFRA Carbon Conversion Factor - Direct Fuel Bun Emissions (kgCO2e/kg fuel)	3.1497
DEFRA Carbon Conversion Factor - WTT Emissions (kgCO2e/kg fuel)	0.6493
Total Direct Fuel Burn Emissions (tCO2e)	1,138.72
Total Direct WTT Emissions (tCO2e)	234.74
Total Emissions (tCO2e)	**1,373.47**
Additional Carbon Per Passenger (tCO2e)	0.00008
Additional tCO2e Globally[95] (tCO2e)	238,220
Percentage contribution to global aviation CO2 emissions	**0.03%**
FUEL COST	
Additional Fuel Cost at Manchester (GBP)	£237,166.40
Additional Fuel cost per passenger (GBP)	£0.013
Global Fuel Cost (GBP)	**£41,135,126**
Airline Industry spend on Jet Fuel per year (GBP)[96]	£134,511,410,640
Percentage contribution to global aviation fuel costs	**0.03%**

For fuel cost, the researcher conducted a similar approach; first by converting tonnes of additional fuel into litres, based on the 'specific gravity'[97] of this fuel – at 0.8 litres per kilogram, and then multiplying this based on the Jet A1[98] fuel price of £0.82 per litre. The result was additional fuel cost for airlines as a result of WDFG activity at Manchester Airport of £237,166 per year. By calculating this on a per

93 Based on 17,873,188 passengers in 2010 (MAG, 2015)
94 Based on 22,055,258 passengers in 2014 (MAG, 2015)
95 Based on 3,100,000,000 annual passengers globally (ATAG, 2015)
96 IATA (2015)
97 the ratio of the density of a substance to the density of a reference substance – in this case used to convert litres of Jet A1 Aviation fuel to kilograms.
98 The aviation fuel used in Europe.

passenger basis (£0.013/person) and multiplying by global passenger figures, this calculated a total cost to the airline industry of £41,135,126 per year.

Both being derived from fuel burn, the proportion (globally) of carbon emissions and fuel cost from WDFG products being taken onto aircraft should be the same. To confirm this the researcher calculated the proportion of fuel that the duty and tax- free sector is responsible for globally based on 2014 global jet fuel spend of £134,511,410,640 (IATA, 2014). As with carbon, this also produced a result of 0.03%. The research believes that this lends credibility to his results as the global carbon and fuel cost impacts for the airline industry were both derived individually from external sources. That this research has found that fuel burn results in the same proportion of impacts therefore suggests that the calculations conducted above are accurate.

6.4.3.6 Observations

6.4.3.6.1 Contributing destinations

In terms of the impacts of additional weight resulting from WDFG sales to particular locations, a number of observations can be made that indicate that WDFG may be able to target reductions in aircraft fuel burn by focussing on certain routes. Firstly, as illustrated in Figure 6-12, the rank of destinations by additional fuel burn, compared to weight carried, shows significant differences in terms of length of flight. The average flight time of products taken to the top 25 destinations by weight sold was 4.8 hours, whilst the average flight time of the top 50 destinations by additional fuel burn was 7.4 hours. Whilst one may expect that longer haul flights will inherently have greater fuel requirements than shorter haul flights, this nonetheless empirically establishes that products being taken onto aircraft has a greater impact on destinations that are further away from point of departure. This is further illustrated through the fact that, when ranked by weight, the top 25 destinations WDFG products were sold to featured 7 short haul destinations, compared to just none when ranked by additional fuel burn. Dublin for example drops from 5th place to 61st place respectively when weight and fuel burn are ranked.

Top 25 Destinations ranked by additional weight carried					
Airport Long Name	Flight Time	Haul	Rank by Weight	Rank by Fuel	Difference
Dalaman (Mugla)	4.5	Medium	1	1	0
Sharm El Sheikh (Ophira)	5.5	Medium	2	2	0
Tenerife (Surreina Sofia)	4.5	Medium	3	5	-2
Bodrum (Milas)	4.1	Medium	4	6	-2
Dublin	0.9	Short	5	61	-56
Orlando	9.2	Long	6	3	3
Dubai	7.6	Long	7	4	3
Antalya	4.3	Medium	8	10	-2
Arrecife (Lanzarote) Canary Is	4.4	Medium	9	13	-4
Monastir	3.2	Medium	10	27	-17
Larnaca	4.8	Medium	11	17	-6
Toronto	8.0	Long	12	8	4
Stockholm (Arlanda Apt)	2.3	Short	13	46	-33
Copenhagen (Kastrup)	1.9	Short	14	59	-45
Barbados (Bridgetown-Seawell)	8.7	Long	15	9	6
Hurghada	5.5	Medium	16	16	0
Paphos	4.7	Medium	17	25	-8
Zurich	1.9	Short	18	60	-42
Las Palmas	4.6	Medium	19	30	-11
Palma De Mallorca	2.6	Short	20	49	-29
New York/Newark Nj Apt	8.0	Long	21	12	9
Alicante	2.8	Short	22	47	-25
Cancun	10.7	Long	23	7	16
Malaga	3.0	Medium	24	44	-20
Geneva	1.9	Short	25	66	-41

Top 25 Destinations ranked by additional fuel burn					
Airport Long Name	Flight Time	Haul	Rank by Weight	Rank by Fuel	Difference
Dalaman (Mugla)	4.5	Medium	1	1	0
Sharm El Sheikh (Ophira)	5.5	Medium	2	2	0
Orlando	9.2	Long	6	3	3
Dubai	7.6	Long	7	4	3
Tenerife (Surreina Sofia)	4.5	Medium	3	5	-2
Bodrum (Milas)	4.1	Medium	4	6	-2
Cancun	10.7	Long	23	7	16
Toronto	8.0	Long	12	8	4
Barbados (Bridgetown-Seawell)	8.7	Long	15	9	6
Antalya	4.3	Medium	8	10	-2
Goa	9.7	Long	30	11	19
New York/Newark Nj Apt	8.0	Long	21	12	9
Arrecife (Lanzarote) Canary Is	4.4	Medium	9	13	-4
Philadelphia	7.8	Long	29	14	15
Montego Bay	10.2	Long	48	15	33
Hurghada	5.5	Medium	16	16	0
Larnaca	4.8	Medium	11	17	-6
Atlanta	9.4	Long	45	18	27
Punta Cana	9.6	Long	47	19	28
Abu Dhabi	7.2	Long	31	20	11
Islamabad Int	7.8	Long	39	21	18
Sandford	9.5	Long	51	22	29
Vancouver	9.7	Long	52	23	29
Porto Plata	9.4	Long	53	24	29
Paphos	4.7	Medium	17	25	-8

Figure 6-12; showing how the top 25 destinations for product sales and weight differ depending on whether they are ranked by the former, or the latter. The arrows indicate if the destination has risen, fallen, or stayed the same, in terms of its rank compared to fuel burn or weight respectively.

6.4.3.6.2 Contributing products

The research has shown that certain product categories are responsible for much of the fuel burn impacts (environmental or financial in nature) that result from WDFG activities in the airport. For example, the spirits category alone accounts for over 50% of 'weight' sold at the airport despite accounting for under 20% of sales; whilst the top three categories by weight (spirits, fragrance, and cosmetics) account for over 70% of total sold. This suggests that WDFG could target weight savings initiatives on only these categories to eliminate a large proportion of weight, without causing large disruption to the rest of their business model. For example, these products could be targeted by a collection on arrival campaign, or their manufacturers could be engaged with to encourage lighter packaging – particularly on less expensive brands that are marketed on cost rather than image. Failing this, these products could be subject to a carbon-offset fee to minimise the impact of them being taken onto aircraft.

6.5 Uncertainty overview and materiality analysis

The carbon inventory provided in this chapter is based on a large sample of accurately measured data, supplemented by a number of informed assumptions. Some of these assumptions are likely to have more influence upon the results described in this chapter than others, depending on the reliability of the assumption, and where it occurred in the calculation process. The GHG Protocol (WBCSD & WRI, 2004) describes uncertainties relating to GHG inventory calculations as being either scientific or estimation in nature:

- Scientific uncertainty arises when the science behind the actual emission process is not properly understood, and the fact that significant latent uncertainty surrounds the complex issue of climate change and the global warming potential of given emissions.
- Estimation uncertainty arises whenever GHGs are quantified. In these instances, it is difficult to accurately measure the carbon emissions that arise from an organisation. This is due to the wide range of emissions sources, types, and the fact that such emissions may occur indirectly (as in the case of Scope 2 and 3 emissions) in such a way that calculating the exact amounts of GHGs emitted through an activity is almost impossible.

'Scientific uncertainty' surrounding this research is negligible, as the research has been conducted with a strong awareness and understanding of the issues surrounding climate change, as evidenced through the literature review presented in Chapter 2, and by closely following the GHG Protocol framework. There is however, some ‘estimation uncertainty’ surrounding the figures produced in the carbon inventory, due to the inherent issues surrounding the data, and the fact that there were a number of instances in the calculations where broad assumptions had to be made. Assumptions that were made for each for the emission activity sources are provided in Table 6-17, together with a comment on the level of uncertainty that such assumptions have contributed.

As can be seen, it is in the opinion of the researcher that assumptions made are at a worst case informed by discussion with WDFG employees, and furthermore, were possible, have been based on real-world data. This, combined with the fact that many assumptions only impact on relatively small aspects of the calculations, suggests that the figures produced in this chapter are reliable, certainly in terms of the research question, to determine the ‘scale’ of emissions that result from WDFG activity and the threat this may pose to the organisation, rather than to identify an exact amount.

Table 6-17;Summary of key assumptions used in this chapter, including uncertainty assessment and potential impact thereof.					
Scope	Source	Method of activity data collection	Assumptions	Uncertainty	Potential Impact on the results
1	Delivery Trucks to Manchester Airport terminals	Function of distance travelled, vehicle type, fuel type, vehicle capacity filled	Distance travelled to the airport assumed based on Google Maps shortest Route. Airside ground movement distance assumption based on WDFG staff knowledge.	Medium - minimal, well-informed assumptions.	Low - Medium uncertainty, combined with relatively small impact for this emissions source means that even if assumptions were incorrect, the impact on the results would be negligible.
1	Business Travel for Manchester Airport employees	Estimation based on number of business travelling staff at Manchester Airport, number of off site visits per year, percentage times travelled per mode.	Assumed number of staff who travel, times travelled per year, distance travelled, and mode of travel. Mode and distance informed by secondary data collection. Number of staff who travel informed by discussion with WDFG Health, Safety and Environment Manager.	Medium / High - Potentially greater number of journeys and distances travelled.	Low / Medium - unless the assumptions are out by a considerable margin, this should have limited impact on calculation results.
2	Electricity for in store energy operations	The amount of purchased energy for each Terminal site was collected.	WDFG were able to provide accurate data for this emissions source, other than heating costs - currently captured in airport rents and not measured.	Minimal. Activity data is measured, with DEFRA conversion factors applied.	Low - despite being a significant contributor to company emissions, the high level of data accuracy for this emissions source means that potential impact of assumptions is low.
3	Staff commuting	Distance of commute calculated as function of home post-code and Manchester Airport postcode. Mode of travel assumed to be the same of all Manchester Airport employees.	Number of employees commuting, and distance travelled obtained from WDFG, and Google Maps. Modes of transport informed by airport wide travel statistics.	Medium uncertainty. Activity data is calculated, but with strong data driving any assumptions used.	Low / medium - A relatively large source of carbon but with relatively robust assumptions.
3	Water Usage	Water bills for WDFG operations provided by the company. Water rents charged to Stanstead Airport used to convert in to volume of water used.	Assumption that Stanstead Airport water unit charges are similar to those at Manchester.	Low - only one assumption made, and informed by data from another WDFG site.	Low - Assumption likely to be relatively reliable. Limited impact of water to overall emissions means that impact likely to be low.
3	Waste Disposal	WDFG waste is collected centrally from all sites, at which point it is measured.	Assumed that waste production from different WDFG sites corresponds to passenger numbers as a proxy to which to determine where waste may have arose.	Medium - companywide waste is accurately monitored, and the assumption is relatively robust.	Low - a relatively robust assumption, for an emission source with relatively low carbon emissions.
3	Products taken onto aircraft	Calculations are based on 3% figure being applied to the COW Formula. The formula suggests that this figure varies depending on flight length.	3% figure applied to all distances	Low - the assumption is based on a widely used methodology, and is commonly cited as being used in industry.	Low - materiality analysis has illustrated that by increasing this figure as high as 4% results in only a small change in overall results, on when grossed up to a global figure.

Table 6-17;Summary of key assumptions used in this chapter, including uncertainty assessment and potential impact thereof.					
Scope	Source	Method of activity data collection	Assumptions	Uncertainty	Potential Impact on the results
3	Products taken onto aircraft - dealing with product weight errors	Use of a robust multi-phase methodology, as detailed in Table 6-10.	Either weights calculated based on gross weight and case size, or an average weight per product category was applied.	Low - the robust methodology that deals with the underpinned assumptions and the relatively small number of items with weight issues means that weights used should be accurate.	Low - Small number of affecting items and a robust methodology to ensure that adjusted weights are well informed.
3	Products taken onto aircraft - Accounting for products sold by WDFG, not taken onto aircraft.	Discussions with members of staff at WDFG.	Assumed that 10% products sold by the company would not end up on aircraft	Medium / High - an informed assumption, but one not rooted in data.	Medium / High - The degree to which this assumption differs from the actual figure will have a corresponding impact on the ultimate figures calculated.
3	Products taken onto aircraft - grossing up sample fuel burn data for all of Manchester Airport, 2014.	Figures were grossed up to account for 100% of weight flown. To bring data up to 2014 levels, from a 2010 data set, fuel burn per passenger was calculated from the 2010 data and multiplied to 2014 passenger numbers.	Assumes that the remaining weight not included in the calculations would have a similar profile to those in the data set.	Medium - despite representing a small amount of weight sold by WDFG, the number of destinations (723) was significant and distributed all over the world.	Low - despite medium uncertainty the fact that only a small amount of product weight was not included in the data set means that any errors would have a negligible impact overall.
3	Products taken onto aircraft - grossing up Manchester Airport data to global scale.	Fuel cost and carbon per passenger calculated and applied to global passenger numbers	Assumes that all airports globally sell the same type of products in the same volumes as at Manchester Airport. Additionally assumes that passengers have the same buying habits.	Medium - Discussions with WDFG employees and reviews of the literature suggest that different airports sell different products, and in different volumes, based on a variety of factors (i.e. cultural or economic in nature).	Low/Medium - Whilst product ranges may differ, the categories of products sold in duty-free outlets remains relatively the same. Different purchasing habits likely the biggest cause of error.

6.5.1 Materiality analysis

Materiality analysis helps to evaluate uncertainty by observing system responses to a modification in a given design (Lam *et al.*, 2008). It does this by computing the effects of changes to input values used in the carbon inventory, to identify which of these might have the greatest influence on the results produced (Morgan and Henrion, 1990). According to Morgan and Henrion (1990), this analysis may be performed at a number of different levels, but is often conducted simply through the modification of one or more input values into the carbon inventory, and by examining the results (Rypdal and Flugsrud, 2001).

This approach was taken in the present research, as detailed throughout this section. Through this testing it can be seen that no one assumption had a marked impact on the findings of this chapter, certainly in terms of the requirement to understand the scale of emissions that the airport retail sector may make to global aviation emissions. The researcher is therefore confident that the results provided in this chapter are robust enough to answer Research Question Two of this thesis.

6.6 Summary

The WDFG business model identified in Chapter 5 recognised that airport retailers are distinct from the majority of high-street retailers, due to being located in the airport environment (i.e. the physical, legislative and logistical impacts on business activity). This results in a business that is more energy intensive in terms of its direct in-store energy demands and through the increase in aircraft fuel burn. Importantly, the latter is an issue with which high-street retailers do not have to contend. Considering the pressures faced by the retail and air transport sectors in terms of climate change and energy use, it is therefore important for WDFG to address both these impacts.

Ground based emissions resulting from WDFG activity at the airport also represent a significant issue for the airport operator, in terms its ability to meet its own carbon objectives. In light of the commercial and political pressures facing airports to reduce the carbon intensity of their operations, WDFG therefore must do everything it can to reduce these carbon impacts, so as to support their service partners. Doing so will help to strengthen the position of the airports when seeking to facilitate airport growth – with a positive feedback loop of more passengers meaning more potential WDFG customers. Additionally, this may increase WDFG’s potential to succeed in bids to operate in other airports, or to renew contracts at existing ones, by illustrating how they are able to help airports meet their sustainability goals.

Of these on-the-ground based emissions, only in-store energy emissions, product distribution and staff travel represent areas for significant carbon savings, and so should be targeted as a priority. Energy usage in-store holds the greatest potential for carbon reductions from ground sources of carbon, accounting for 35% of total company emissions at Manchester Airport. The fact that WDFG are however already engaging in this area by implementing energy reduction initiatives suggests that whilst further efficiencies may be possible, they may prove difficult to achieve. As a result, further, substantial efficiencies may require significant changes to the incumbent business model – for example engaging with suppliers to change the way products are displayed (so as to reduce in store lighting). Doing so however could be difficult to facilitate as discussions as high levels of illumination are seen as key to product sales. As a result, the company is reluctant to reduce lighting in any significant way. Where further energy reductions are not possible, the company could seek to purchase renewable energy through its contract with the airport operator, or even invest in its own renewable energy plant.

Staff travel holds some potential for reductions, in that it accounts for 19% of organisational carbon impacts. Initiatives to reduce are however reliant on encouraging employees to use public transport or car share, rather than seeking to reduce distance travelled, as the majority of WDFG staff are required on site - thus making options such as homeworking inappropriate.

Finally, carbon that results from the company’s logistical delivery fleet holds some potential for further savings – however this is also subject to difficulties. This source represents less than 10% of company emissions, and WDFG is already engaging in energy reduction – from using highly efficient vehicles, to ensuring all delivery trucks operate at maximum capacity so further opportunities for improvement are limited. This is an intrinsic activity of the current business model on which the company is totally reliant and further reductions would require wholesale changes in the company business model, but again opportunities for developments in this area, such as home delivery, are limited due to the airport setting.

All the above suggests that reducing the weight and emissions arising from products being taken onto aircraft may offer the greatest potential for WDFG to cut the carbon intensity of its operations, even though these are actually Scope 3 emissions for the company.

Whilst the overall increase in aircraft CO_2 emissions at a global level from airport retailing is estimated to be quite small (0.03%), in absolute terms of tonnes CO_2 emitted (194,548 tonnes) this is nonetheless a significant amount.

Given that aviation's carbon emissions are forecast to grow at a time when Governments are seeking significant CO_2 reductions this volume of carbon could become the focus of attention from NGOs, airlines or governments.

Of potentially greater threat is the additional fuel or emissions taxes cost to airlines. Again, proportionally this is a small amount (0.03%), but in commercial terms, and on particular routes, it can represent a significant figure. Airlines may begin to dissuade passengers from bringing excessive hand luggage on-board in the future. It is therefore logical for the company to address this weight from a risk aversion perspective to protect income streams, in terms of improved corporate image, and competitive advantage.

Although products taken onto aircraft represent the greatest individual source of carbon emissions associated with their current business activity, WDFG have yet to engage with this issue in any meaningful way. Presently efforts are limited to offering a selection of lower-end products (e.g. spirits) in plastic rather than glass packaging, and by offering a collection on arrival service for passengers. Encouraging greater use of plastic packaging would have limited potential, especially for high-end products, as it would run against images of luxury and exclusivity. With regard to expanding collection on arrival, the sales data set provided by WDFG for Manchester shows that this service avoided 58 tonnes of product being taken onto aircraft - 2.8% of all 'weight' sold by the company. This approach may offer the best opportunity to deliver carbon reductions in this area, but it presents significant logistical challenges and could adversely impact on sales as discussed elsewhere.

The findings in this chapter suggest that WDFG may be able to reduce this additional fuel burn by targeting certain product categories (for example 'Spirits' are responsible for over 50% of weight sold through WDFG products), or certain destinations (for instance, the top 30 destinations by weight flown represent over 50% of all weight sold as WDFG products). For example the company could expand their collection on arrival service (but again, although not impossible, this is fraught with logistical and commercial challenges).

If it were not possible to adopt a new business model that reduced aircraft weight, then one very straight forward approach to mitigating the climate change impact would be through the purchase of carbon offsets[99]. This would cost c. £11,000 for all products sold at Manchester Airport, based on a carbon-offset cost of £8 per tonne[100]. Furthermore, as shown in Table 6-18, the cost to offset individual products is minimal, with a single bottle of champagne (at average weight for that product category), costing just 3 pence to offset, for even a 20 hour flight.

Table 6-18; CO_2 and Associated Carbon Offset costs for the three heaviest product categories sold by WDFG.

		Champagne		Spirits		Wines	
Average Weight per Category (kg)		1.88		1.77		1.38	
Haulage	Flight Time	CO_2 (kg)	Offset Cost (£)	CO_2 (kg)	Offset Cost (£)	CO_2 (kg)	Offset Cost (£)
Short	0.50	0.11	0.09	0.10	0.08	0.08	0.06
Short	1.00	0.22	0.17	0.20	0.16	0.16	0.13
Short	2.00	0.43	0.35	0.41	0.33	0.32	0.25
Short	3.00	0.65	0.52	0.61	0.49	0.48	0.38
Medium	4.00	0.87	0.69	0.82	0.65	0.64	0.51
Medium	5.00	1.08	0.87	1.02	0.82	0.79	0.64
Long	10.00	2.16	1.73	2.04	1.63	1.59	1.27
Ultra-Long	15.00	3.25	2.60	3.06	2.45	2.38	1.91
Ultra-Long	20.00	4.33	3.46	4.08	3.26	3.18	2.54

The cost to offset emissions from the WDFG business would therefore represent a very small addition cost to alleviate much of the pressure it could face as a result

[99] Carbon offsetting is the use of carbon credits to enable businesses to compensate for their emissions, through schemes such as carbon sequestration, or increasingly through schemes designed to help those impacted by climate change meet their carbon reduction goals and support the move to a low carbon economy (Hooper and Preston, 2008)

[100] http://www.carbonneutral.com/

of its carbon emissions. Alternatively, the cost of offsetting could be included in the price of products sold. This could be done without the awareness of customers, or it could be used as a public relations exercise to communicate that the company are doing everything they can to tackle the carbon threat.

7. Summary of findings and discussion

7.1 Introduction

This chapter presents the analysis of the results drawn from the research phases detailed in Chapters 4, 5, and 6. It brings together those findings using the Comprehensive Strategic Analysis Framework (see Boardman, Vining, and Shapiro, 2004) described in Chapter 3, and illustrated in Figure 7-1 below. First, it describes the *Situation Analysis* which is designed to identify the current position of WDFG based on its operations, and the environmental impacts that result. This is followed by *Fulcrum Analysis,* in which the call to action for some level of organisational change by the company is described. Finally, the chapter presents the *Solution Analysis* for the firm - that is, potential solutions to this call to action that may see WDFG enhance its resilience to the sustainability challenge and so remain profitable into the long-term future. This approach underpins the overarching aim of this research, that is; *"To better understand how airport retail business models will have to evolve in response to the challenges arising from climate change and peak oil."* which is further discussed in the concluding Chapter 8.

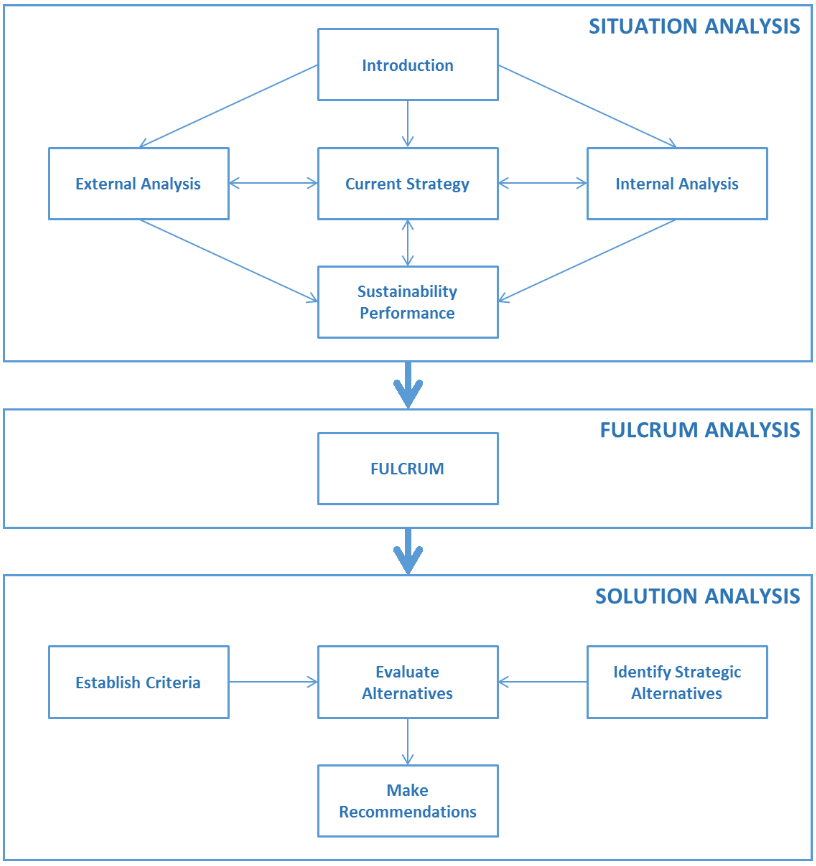

Figure 7-1; The adapted Comprehensive Strategic Analysis Framework used in this thesis (after Boardman, Shapiro, Vinning, 2004)

7.2 Analysis Phase 1; Situation Analysis

This aim of this section is to bring together the findings from the previous chapters, in order to describe, analyse and evaluate the current operating situation WDFG finds itself in, and inform on the threats and risks the company is likely to face in the future to facilitate Fulcrum Analysis presented in Section 7.3.

7.2.1 Introduction

WDFG is a good example of an airport retailer that is commercially highly successful, and that is expanding its influence globally. The business does however face a number of external threats that it must anticipate and adapt to, for continued financial success. Based on the incumbent WDFG business model, and in the context of the aviation sector – with which the company has a symbiotic relationship – these issues represent a potentially significant threat to WDFGs ability to generate revenue in the longer term.

7.2.2 External (sector) analysis

The airport retail sector is highly profitable, focused around the sale of typically luxury branded products, to airline passengers. Its success is based on large, captive audience with a high propensity to buy, a typically large amount of 'dwell' time[101], and its offering of perceived economic savings compared to the high street. The sector has experienced continuous growth for many decades and is a key source of revenue for airport operators. As such, airport retailers can now be regarded as a vital stakeholder in the aviation industry.

The sector is expected to continue growing for the foreseeable future, however the literature identifies a number of external risks. These range from the growth of on-line retailing, to an ageing demographic with less propensity to spend, falling disposable income in economically developed nations, and the growth of low cost carriers, that typically attract passengers who spend less in the airport (Verdict, 2015; Lei and Papatheodorou, 2010; Sevcik, 2014). A number of opportunities exist for retailers to maximise revenues despite these challenges, however they require the sector to innovate; for example, by taking advantage of mobile

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[101] Albeit that there are many instances where passengers may be short on time.

technologies that will enable passengers to browse product ranges before arriving at the airport (Verdict, 2015).

Significant potential risks absent from the literature are those linked to the environmental issues of climate change and peak oil. These pose a number of threats to airport retailers, from broad risks associated with all businesses and retailers (for example, threats to supply chains, and rising energy prices), to the specific risks faced by the aviation sector (for example, the fact that retail products are typically taken onto aircraft increasing fuel burn). The symbiotic relationship between the airport and the retailer means that, for its own long-term commercial security, retailers need to mitigate such impacts through reduced carbon emissions, and ensure that they are responsive to airport and airline ambitions to do the same.

7.2.3 Internal (company) analysis & current strategy

WDFG is a profitable organisation that can demonstrate long-term continuous growth in its revenue, and in terms of the number of airports at which it operates. The company typically operates under the ‘master concessionaire’ model of the airport retailer, in which it is hired by the airport operator to provide the service of retailing, based on the quality of its services, its profitability and its expertise in this field. This provides WDFG with access to a high number of potential customers, for which it pays lucrative rents to airport operators, in some cases including a percentage of revenues made from airport sales. This model has seen the company generate continual profits and growth, despite a number of restrictions that surround the airport setting, both physical (i.e. limited space for sales and product storage), and regulatory in nature (i.e. a requirement for sales to only take place within the airport environment, reducing the number of potential customer relationships and channels).

To maximise revenues, WDFG have adopted a highly focused business model appropriate to the airport setting, for example by developing leading-edge logistical systems that enable items to always be available to customers, despite minimal storage space available at each site. This has seen the business focus on meeting customer expectations as its primary value proposition, for instance through the offering of luxury and exclusive products as well a value items, a wide range of brands, low prices, and high levels of customer service.

As well as competing for the custom of airline passengers, WDFG must also compete with other retailers to obtain the right to operate at airports. This has seen the company place a great deal of attention on developing strong partnerships with airport operators to aid the renewal of operating contracts or to win contracts at new locations. Obtaining a unique portfolio of airport locations is a central component of WDFG strategy, and so meeting airport operator demands is thus a key objective for the company. WDFG have already had to respond to the issue of climate change by providing low-carbon business practice as part of a bid for contracts.

7.2.4 Sustainability analysis

Key figures relating to the environmental impact of airport retail activities produced through this research are presented in Table 7-1.

Table 7-1; Key figures pertaining to the environmental impact of WDFG produced through this research.	
Carbon emissions from WDFG in-store energy usage at Manchester Airport (tCO2e)	1300 (or 35% of company emissions at the airport)
Total 'weight' of products sold by WDFG at Manchester Airport	1913 tonnes per annum
Additional fuel burn for airlines resulting from WDFG sales at Manchester Airport	293 tonnes per annum
Additional CO_2 emissions for airlines resulting from WDFG sales at Manchester Airport (tCO2e)	1373 (or 37% of company emissions at the airport)
Additional airline fuel cost resulting from WDFG sales at Manchester Airport	£237,166
Global carbon emissions from aircraft resulting from the Duty-Free sector (tCO2e)	238,220
Global fuel cost for airlines resulting from the Duty-Free sector	£**41,135,126**
Percentage of additional global airline carbon emissions and fuel costs that result from Duty-Free	0.03%

As detailed in Chapter 6, WDFG operations at Manchester give rise to some 3,746tonnes CO_2e per annum. Approximately 1300tCO_2e, or 35% of company emissions, arise from in-store energy usage, however, the company's largest single source of carbon emissions (38% of total emissions) was found to be those that arise from products WDFG sell being taken onto aircraft by passengers. This is significant for a number of reasons:

- The environmental imperative for all businesses to reduce carbon emissions.
- The potential political pressures on aviation and a retail business model that gives rise to secondary ('unnecessary') emissions that are not essential to enable flight.
- Financial pressures arising from the additional fuel and emissions costs faced by airlines.

These indirect emissions are unique to the airport retailer and are a direct consequence of the current operating model. As the root source of these emissions WDFG is best placed to be able to reduce them through new business models, operating practices, and engagement with product brands, and passengers.

With regards to emissions from in-store activities, being aware of the importance of sustainability issues, WDFG have implemented a number of initiatives aimed at improving its environmental performance. These are, however, rooted in resource and material efficiencies (primarily linked to direct energy use and waste management) that enable carbon reductions (mainly linked to Scope 1 emissions[102]), as well as bottom line cost savings. Importantly, they enable the business to continue in a largely business-as-usual way – an understandable approach considering the overarching objectives of the company to generate shareholder return, and in a business world where ideas of environmental sustainability are still relatively nascent. WDFG have introduced two primary initiatives that minimise the amount of weight taken onto aircraft. Firstly, a limited number of low-value alcoholic beverages are sold in plastic rather than glass packaging. Secondly the ability to collect items on arrival at a limited number of locations (which is only applicable for passengers returning to the same airport from which they depart). Beyond this however, the incumbent business model

[102] emissions are direct emissions from owned or controlled sources. Scope 2 emissions are indirect emissions from the generation of purchased energy.

shows little sign of conforming to the sustainable business model archetypes identified by Bocken *et al.* (2014) and discussed further in Section 7.3.

7.3 Analysis Phase 2; Fulcrum Analysis

The Fulcrum Analysis phase of Comprehensive Strategic Analysis presents the call to action for the focal firm, using Situation Analysis as its input (Broadman, Shapiro, and Vining, 2004). In this Section, the analysis considers the call to action in terms of the sustainability challenges facing the airport retail sector, and the context of the wider aviation industry.

WDFG operate in a commercially attractive setting; the high levels of passengers they have access to, and the generally high propensity to spend of many of those passengers means that company revenues outstrip those found on the high street. This is despite a number of constraints on the business that might otherwise see it prosper further, i.e. by not being able to offer additional product channels. Its success is therefore built upon a high degree of specialisation or adaptation.

With a business model portfolio that lacks diversification, the continued success of WDFG hinges on the company's ability to operate optimally in the airport environment. Thus, alongside maximising sales, a further key success factor, as indicated above, is its ability to gain new airport contracts and to renew existing contracts. At present WDFG excels at this, as evidenced by its high contract renewal rate of 96% (WDFG, 2014b), its strong position in the UK and Spanish markets, and its expansion into new markets – particularly the United States (WDFG, 2014b). In a highly competitive sector featuring a number of similarly sized retailers, however, it is necessary for the company to seek competitive advantage over its rivals. In the context of growing environmental pressures upon airports, particularly in terms of its carbon emissions, sustainability and environmental issues could provide such a differentiator.

In terms of the environmental impacts that result from WDFG activities, the current business strategy appears appropriate in that (as shown in Sections 4.3.1.3 and 7.2.4), it focusses upon maximising resource use and energy efficiencies, both of which deliver financial savings. There is also evidence of the company taking a stewardship role in certain airports (for example London Heathrow) where it is a lead participant in the airport's Sustainability Partnership (WDFG, 2014a), indicating that it is seeking to support the environmental programmes of its airport partners. In terms in-store activities, this research has estimated that WDFG accounts for approximately 7% of total energy demands at Manchester Airport[103] (MAG, 2014). Considering the significant revenues that WDFG generates for airports, and that fact that such emissions can be mitigated through purchasing renewable energy, this issue is unlikely to emerge as a commercial threat in the short term at least. However, WDFG would nonetheless benefit from demonstrating its ability to operate a low carbon business and support the sustainability objectives of its airport landlords, in so doing securing competitive advantage in renewing and gaining new operating contracts.

With regard to the wider implications of WDFG activities for airline emissions, the fact that additional weight carried by aircraft as a result of airport retail contributes just 0.03% of global carbon emissions suggests that it may not pose a significant threat in the short-term. In the longer term, however, as the evidence of climate change becomes more apparent, this may not remain the case, simply because aircraft emissions are forecast to rise and technological solutions will not compensate for growth. Furthermore, although 0.03% may be small in proportional terms, in absolute terms this is nonetheless almost 200,000 tonnes of CO_2 annually.

A more pressing issue for WDFG is the additional fuel costs that this weight results in for airline operators. The research has shown that this represents approximately £41million per annum, or 0.03% of total industry spend on jet fuel (IATA, 2014). As fuel costs rise[104] (due to, in part, the issue of peak oil), this could have a greater impact on WDFG operations. This threat would be most likely to emerge on long-haul flights and on routes where airport retail sales result in a large amount of additional weight. For example, flights from Manchester, UK, to Dalaman in Turkey were found to carry an average additional weight of 80kg per flight. This figure is significant in that it is comparable to the levels of weight saving already being pursued by airlines. For example, Air Canada Jazz removed life vests from all of its planes to make weight savings of 23kg, whilst Japan Air flew aircraft that were unpainted – saving 150kg per flight (Mason and Miyoshi, 2009). Meanwhile, low cost carriers such as Ryanair have previously implemented the one-bag rule to

[103] Based on carbon emissions from energy usage of 19,000tCO2e at Manchester Airport (see MAN 2014), and 1,299tCO_2e emissions from WDFG in-store energy usage at the airport (see Chapter 6).
[104] (see Wold Bank, 2015)

reduce passenger carry-on weight (Branquinho, 2010), negatively impacting on passenger experience, and potentially on duty free sales.

The fact that airlines are already seeking opportunities to reduce the weight, some of which would impact retail sales, indicates the need for WDFG to find its own solutions to this source of aircraft emissions - in ways that maintain existing levels of income.

As identified in Chapter 5 of this thesis, the business model and operations of airport retailers have developed in response to a number of specific criteria and characteristics related to the airport setting. The challenge for WDFG is to identify low-carbon business models that comply with these criteria, detailed in Section 0 and summarised below.

Sustain current revenues and support business growth

Delivering financial return to shareholders and the airports for whom they are tenants is critical. Therefore new business models must:

- be low risk in terms of implementation (scale of change and the threat of new entrants);
- meet customer expectations and not have adverse impact upon propensity to buy;
- meet the requirements and demands of suppliers (for example the current expectation that high value goods have excessive packaging and require high levels of lighting);
- reduce bottom line costs for WDFG;
- generate as a minimum, current revenues for WDFG and airport landlords;
- help WDFG to grow their business, through revenue streams in existing stores and through the acquisition of contracts at new airport sites.

Deliver Carbon Reductions for WDFG, Airports and Airlines

Any new business model must deliver absolute or relative energy and carbon reductions for WDFG, for its airport landlords, and for airlines. Where further reductions cannot be achieved, consideration should be given to mitigation activities such as:

- purchase of renewable energy or construction of renewable energy generating infrastructure.
- purchase of carbon offsets for flight emissions.

Fit with Operational Constraints and limitations

Any new business models would have to be able to accommodate:

- the limitations of physical space imposed by the airport setting;
- limited customer contact time;
- security issues;
- the operational limitations imposed by other airport activities (for example where consideration were given to collection of arrival).

Conform with Legislative Requirements

The requirement that duty free goods must be sold airside in the airport and the passenger must take physical ownership of the product, or pay for it and collect upon return. This prevents options such as home delivery.

Figure 7-2; illustrating the criteria that any new business model must adhere to for WDFG to effectively move towards the requirements of a low-carbon, sustainable society.

Finally, a new business model can only be considered commercially sustainable if it does not weaken the position of the company in the sector. For example, it might be argued that a change in the law that allowed duty free goods to be delivered to the home could dramatically reduce the secondary carbon emissions arising from products being taken onto aircraft. However such a change could provide a significant opportunity for a company such as Amazon, that is better adapted to the home delivery market to move into airport retailing and become a significant competitor to WDFG. This potential threat has already been recognised in the case of Heinemann Duty Free which, in 2014, developed an on-line ordering and home delivery service – available only to those travelling from German Airports (F Lawrence 2014, pers. comm., 27 November). WDFG management believe that this weakens the position of all duty free retailers, by eroding their position of being exclusively bound to the airport, meaning that external retailers could argue that they too should be able to operate in this environment. For this reason, WDFG have lobbied for the Heinemann offer to be withdrawn.

Accordingly, WDFG strategy and future business models should seek to reduce its own environmental impacts, and those of its industry partners, but in ways that are economically profitable and compliant with the criteria listed in Figure 7-2. The company needs to acknowledge, however, that in the longer-term, the nature of the business, being rooted in consumption (a root cause of sustainability challenges), will very likely pose an additional threat. Accordingly, ideal alternative business models would be those that deliver profitability, with lower environmental impacts and lower rates of consumption (such as product-service-systems). It is however, unlikely that these business models will prove as profitable for the sector in the medium term at least, considering the current popularity of the airport retail and duty free sector with consumers.

This begs the question; what types of business models could deliver both environmental and commercial sustainability to WDFG? The company can either preserve the incumbent business model and be protectionist (as demonstrated by its response to Heinemann Duty Free), or implement new business models that would deliver profitability but in novel, and low carbon ways and which could potentially open the doors to even greater profitability. It is the identification of such business models that this research looks to address in the following section, through Solution Analysis.

7.4 Analysis Phase 3; Solution Analysis

7.4.1 Introduction

Solution Analysis is the final stage of Comprehensive Strategic Analysis and sees the researcher develop and evaluate alternatives for the focal firm that may address the call to action identified in Fulcrum Analysis (Boardman, Shaprio and Vining, 2004). In the case of the present research, WDFG require low carbon business models that will safeguard it from risks associated with Sustainable Development, but that also comply with a number of criteria, as detailed in the previously in this Chapter.

Accordingly, this section discusses the sustainable business model archetypes identified by Bocken *et al.*, (2014) in the context of these criteria, and the wider carbon and peak oil challenges faced by WDFG, that will empower the company to move towards profitable, yet low-carbon business models. In doing so, this section identifies a variety of different ways in which WDFG could adopt changes to its existing business model that would directly or indirectly support sustainable development and promote greater adherence to the sustainability architypes described by Broken *et. al.* (2014). It is self-evident that the researcher has only been able to touch the surface of the plethora of actions that could be taken (due to the logistical time constraints of the research). There would therefore be considerable benefit in the senior management of WDFG carrying out a formal process to systematically review opportunities in this field.

7.4.2 Assessing the sustainable business model archetypes

As described in Section, 2.5.2, Boons and Lüdeke-Freund (2013) classified sustainable business models by whether they are social, technical, or organisational in nature, from which Bocken *et al.*, (2014) went on to categorise eight archetypes (as illustrated in Table 7-2 below).

These archetypes incorporate the triple bottom line approach to sustainability and consider a wide range of stakeholder interests - including the environment and society - that can drive corporate innovation for sustainability, embed sustainability into business purpose and processes, and serve as the driver for competitive advantage (Bocken *et al.*, 2014). Accordingly, the archetypes act as a useful framework around which it may be possible to identify ways in which WDFG might be able to overcome the challenges described in Fulcrum Analysis.

To begin this process, the researcher analysed each of the eight archetypes identified by Bocken *et al.,* (2014) in the context of the criteria identified in Chapter 5 and presented in Figure 7-2 below. This analysis is summarised in Sections 0 to 7.4.2.8.

Table 7-2; Business Model Archetypes (Bocken *et al*. 2014)		
Groupings	Archetype	Value Proposition
Technological	Maximise material and energy efficiency	Products or services that use fewer resources, generate less waste and emissions and create less pollution than products/ services that deliver similar functionality.
	Create value from waste	The concept of 'waste' is eliminated by turning waste streams into useful and valuable input to other production.
	Substitute with renewables and natural processes	Reduce environmental impacts and increase business resilience by addressing resource constraints 'limits to growth' associated with non-renewable resources and current production systems.
Social	Deliver functionality rather than ownership	Provide services that satisfy users' needs without having to own physical products. Business focus shifts from manufacturing 'products' to maximising consumer use of those products, thereby reducing production throughput of materials, and better aligning manufacturers' and consumers' interests.
	Adopt a stewardship role	Manufacture and provision of products and services intended to genuinely and proactively engage with stakeholders to ensure their long-term health and well-being. Broader benefits to stakeholders often become an important aspect of the value proposition by better engaging the consumer with the full story of production and the supply chain.
	Encourage sufficiency	Product and service solutions that seek to reduce demand-side consumption and hence reduce production (e.g. durable, modular, education about reduced consumption). The focus of such innovation is on the customer relationship and influencing consumption behaviour.
Organisational	Resource for society / environment	Prioritizing delivery of social and environmental benefits rather than economic profit (i.e. shareholder value) maximisation, through close integration between the firm and local communities and other stakeholder groups. The traditional business model where the customer is the primary beneficiary may shift.
	Develop scale up solutions	Scaling sustainability solutions to maximise benefits for society and the environment

7.4.2.1 Maximise material resource use and energy efficiency

This archetype concerns doing more business activity, with fewer resources, and by generating less waste, emissions and pollution (Bocken *et al.*, 2014), in line with the approaches to Sustainable Development espoused by Weizsacker *et al*., (1998) and Natrass and Altomare (1999). As such, this is the most closely aligned of Bocken *et al.* (2014) archetypes to the current WDFG business model as demonstrated by its highly evolved, programs of energy minimisation, waste reduction and recycling, and logistical fleet fuel efficiencies.

Further action within this archetype carries the least risk in terms of implementation of all the archetypes put forward by Bocken *et al.* (2014), as it would see WDFG continue to seek efficiencies, using skills that they are already in the process of developing. This would mean only limited future changes to company processes and structure compared to the other archetypes, and importantly, would enable existing revenues to be maintained.

Importantly, the archetype has the potential to reduce aircraft fuel burn, should WDFG be able to engage with their supply chain to reduce the weight of packaging materials. Such solutions would, however, face a number of barriers, not least that light-weight, non-premium, materials might not fit with the brand image of product suppliers, or of WDFG. Finally, should such materials also fail to meet customer expectations there is the risk that revenues may also be negatively impacted.

Verdict: Compliant with the current business model, and some opportunity for further development.

7.4.2.2 Create value from waste

This archetype does not focus on waste reduction but sees the concept of 'waste' eliminated by turning waste streams into useful and valuable input to other production processes and making better use of under-utilised capacity (Bocken *et al.*, 2014).

Like any other retailer, WDFG activity results in waste. WDFG is already engaging with this archetype by ensuring that all appropriate waste from its business is captured for recycling, whilst non-recyclable waste is incinerated to provide energy at its CDC[105]. To engage further with this archetype, the company would therefore have to address the downstream impacts of the products it sells; either by working with its suppliers to manufacture products out of benign, recyclable materials, or by engaging with its customers, to encourage the responsible disposal of products purchased in retail outlets. The latter is difficult as WDFG only have short-term relationships with the majority of its passengers, whilst the difficulties of engaging with the supply chain have already been discussed. Business models that might enable waste to be reduced higher up the waste hierarchy[106] (i.e. re-use) would be difficult to implement operationally, in terms of consumer engagement, because of the large numbers of WDFG suppliers and because such an approach could detract from luxury brand image.

Verdict: Limited potential for development, but only as ancilliary activity.

7.4.2.3 Substitute with renewables and natural processes

This archetype describes business models that seek to reduce environmental impacts and increase business resilience by addressing resource constraints (i.e. limits to growth) associated with non-renewable resources and current production systems (Bocken *et al.*, 2014).

WDFG is already generating renewable energy through the waste incinerator at its CDC. The company could expand on this by constructing more renewable energy capacity at the CDC, or indeed elsewhere, feeding into the National Grid. Where this is not possible, the company could simply purchase renewable energy (via its contracts with airport landlords) albeit that this may have additional cost implications.

Additionally the company could investigate the use of renewable (or recycled) materials such as timber for outfitting its stores – where this has a measurable carbon benefit, does not impact upon customer expectations, brand image and thus revenues. It could also engage upstream with its supplier and airport partners

[105] Central Distribution Centre.
[106] Preferred waste disposal options ranked by their sustainability.

to do likewise (i.e. linking to the *Adopt a Stewardship Role archetype discuss* below).

Such initiatives would enable the current and profitable business model to largely continue as usual and could have a marked impact on the contribution that WDFG make to emissions associated with its airport activities. It would not however address its largest source of carbon – the weight of products taken on to aircraft.

Verdict: Already present in current business model. Potential for development, but financial implications.

7.4.2.4 Deliver functionality rather than ownership

This archetype describes business models that provide services that satisfy users' needs without having to own physical products – thus reducing consumption and associated implications (Bocken *et al.*, 2014).

Examples of such commercial opportunities would include gambling or experiential activities already found at a growing number of airports. Being an exclusively retail organisation, adoption of this architype could require a radical change in the WDFG business model that may not possible given its current articles of association and would likely require the development of new expertise within the organisation. Finally, they may not deliver the same revenues as the incumbent business model.

WDFG could however implement this archetype as an ancillary activity by offering a product rental service, alongside product sale. For example hiring high-end jewellery and handbags to passengers taking weekend breaks. This could have a number of benefits including:

- Increased revenues from product lease from those who cannot afford to buy.
- Converting rental to permanent purchases if customer likes the product.
- Make the businesses more 'democratic' by providing access of high-value goods to low-income passengers.
- Building the company's expertise at operating such a business model should pressure on the simple retail model mount.

Indeed the potential benefits of this are such that WDFG indicated during the research process that they are already considering the feasibility of such an offer. It should be noted that such a scheme would not necessarily reduce the carbon impacts of the WDFG business model identified in this research, particularly from weight taken onto aircraft. Additionally, delivering such an offer would require a complex logistical system.

Verdict: Very limited opportunity within current business model. Some potential as ancillary activity.

7.4.2.5 Adopt a stewardship role

This archetype describes businesses that proactively engage with all stakeholders to ensure its long-term health and well-being (Bocken *et al.*, 2014). Bocken *et al.* (ibid) suggest that this can be done either upstream or downstream from the business, for example:

- Upstream; WDFG could engage with its suppliers to drive more ethical or sustainable business practices through the supply chain, particularly in ways that benefit its own business – namely by reducing the weight, or nature of materials used in product packaging.
- Downstream; WDFG could proactively engage with airport passengers to encourage use of the Collection on Arrival service (that would reduce the mass of weight taken onto aircraft) or to promote the purchase of carbon offsets (discussed below) to mitigate the weight of products taken onto aircraft.
- More generally, WDFG could expand its current engagement with the airports at which it operates, and other retailers in those airports, to help reduce energy use, through sharing knowledge, and by working collaboratively to find reductions in the airports emissions.

WDFG is already engaging in upstream stewardship, through a range of employee and community based programmes, and Suppliers Policy (WDFG, 2013), which states that suppliers must act in accordance with a set of guiding principles regarding environmental issues – albeit this makes no firm commitment to tackle any specific issue – for example the weight of products sold. The company are also already engaging with the wider airport, through schemes such as the Heathrow Sustainability Partnership (WDFG, 2014a).

Verdict: Already present in current business model. Potential for further implementation.

7.4.2.6 Encourage sufficiency

This archetype represents business models that actively seek to reduce consumption and production (Bocken, *et al.*, 2014). As such, this model runs completely against the existing WDFG business model in which consumption of products is a central component. Furthermore, it goes against the existing demands of airport passengers for access to a wide range of goods, and of airport operators that demand revenue. Such models would therefore face significant opposition from all airport users, and thus be very difficult to implement.

Verdict: Not suitable for the airport setting.

7.4.2.7 Re-purpose for society / environment

This archetype prioritises delivery of social and environmental benefits rather than economic profit (i.e. shareholder value) maximisation, through close integration between the firm and local communities and other stakeholder groups (Bocken, *et al.*, 2014). Examples of business models that fall into this archetype include non-for profit organisations and social enterprises, that would see any revenues raised from business activity invested into pro-social initiatives, for example community projects.

The fact that this archetype would not generate revenue for the retailer (and consequentially for the airport), means that this may not be an appropriate option in this sector in terms of any company wide integration. That said, WDFG has engaged in this archetype to an extent through its One Foundation - the companies charitable division. This initiative seeks to fund clean water projects around the world through the sale of 'One' bottled water, from which the proceeds go to the installation of water pumps in water-deprived areas[107].

[107] In 2014 this scheme had raised over £1.4million (WDFG, 2014c), demonstrating that the company is able, and willing to engage in wider societal issues.

Further ‘pro-social’ activities that would further justify WDFGs place in the airport, and the emissions that it results in, could include for example, development of a carbon offsetting product that could voluntarily, or mandatorily, offset the emissions from products taken onto aircraft (or, if done voluntarily, even the emissions of the passenger themselves). The benefits of such a scheme could be focussed upon developing economies that are directly impacted by climate change, or in communities surrounding airports at which WDFG operates. This would facilitate airport growth by compensating local residents for the adverse impacts of airport operations. As such, it would bring benefits to both its airport and airline service partners.

Verdict: Not compliant with the core business model, but some potential for expansion in terms of enhancing CSR activity.

7.4.2.8 Develop scale-up solutions

The final archetype identified by Bocken *et al.* (2014) describes business models that deliver small sustainable solutions at a large scale to maximise impact. For example, bringing the idea of car sharing to a mass audience[108]. Here, again, the principle of the architype would initially appear to have little relevance to the current WDFG business model, however it is still possible for the Company to exert influence upon others (for example as detailed in 1.3.2.8 by promoting carbon offsetting) through its direct interactions with the travelling public. There could, or example, be potential for WDFG to at least produce documentation that could be included with purchases that promote more sustainable practices (such as offsetting). In so doing WDFG would demonstrate to its customers its own sustainability credentials, a benefit that will become increasingly important in the future. This could potentially compensate for the residual environmental impacts that they are not able address.

Verdict: Some potential as ancillary implementation should WDFG use their access to millions of passengers as a ‘force for good’ by promoting education for Sustainable Development.

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[108] See ZipCar https://www.shellfoundation.org/ShellFoundation.org_new/media/Shell-Foundation-Reports/shell_foundation_scaling_solutions_for_sustainable_mobility.pdf

7.4.3 Summary and discussion

This section has sought to identify which type of sustainable business models may be suitable for WDFG in light of the call to action identified in Fulcrum Analysis. This identified that WDFG need to seek out low-carbon ways of doing business that are commensurable to the demands of the airport setting. In this context, it is possible to make a number of observations that infer the direction WDFG may wish to take in the future, so as to meet these criteria, and be able to thrive in a low-carbon economy.

7.4.3.1 Several archetypes inappropriate in any 'holistic' way

It is clear that WDFG have the potential to adopt or further develop its existing business model to meet a number of Bocken *et al.* (2014) sustainable business model archetypes. For others however, this would be significantly difficult if not impossible, in terms of any holistic, business-wide integration. Many archetypes, for example '*create value from waste'*, 'd*eliver functionality rather than ownership'* and '*Substitute with renewables and natural processes' would* be operational challenging if not impossible given the specifics of the airport environment, and would require a great deal of internal restructuring. As such, the adoption of these archetypes would be dependent on the articulation to senior management of WDFG about the nature, timing and extent of the sustainability risk to the current business model, as well as the cost, risk and opportunities associated with implementing such radically different business models.

Importantly, *'Repurpose for society/environment'*, and *'encourage efficiency'* would struggle to deliver any significant revenues for WDFG, whilst *'deliver functionality rather than ownership'* would be able to do so only as an ancillary activity to the existing business model. This rules out such archetypes in terms of any company wide integration.

7.4.3.2 The Potential of ancillary implementation

Whilst a number of archetypes where discounted as viable options in terms of the company's primary mechanism for generating revenue, they could have some potential as ancillary activities to the incumbent business model. For example, WDFG could maintain the current business of asset sale, however it could also offer a rental service for the same products. Likewise, the company could look to operate under its existing business model, whilst engaging with its service partners and customers to improve its own environmental performance, as per the *Adopt a stewardship role* archetype. Such 'bolt-on' approaches would help develop internal sustainability capabilities so that such innovative approaches could be further expanded further in the future.

7.4.3.3 Limited 'direct' environmental benefits for the aviation industry

It was also observed that many of the environmental benefits these archetypes can bring about typically deal with wider societal environmental issues such as consumption, rather than those that pose an immediate and direct threat to the aviation sector; that is, activities that contribute to airport and airline carbon emissions. Again, this suggests that in the short-term it is unlikely that these business models would be advocated by WDFG as the scale of change required to implement such concepts across the organisation may carry great risk (perhaps even more than the threats of climate change and peak oil), with potentially small rewards. That said, the reduction of weight on aircraft may be possible through the *Maximise material resource use and energy efficiency, Encourage sufficiency, and re-purpose for society* archetypes – albeit only the first of these has the ability to me*et* all the identified criteria.

7.4.3.4 Conclusions and recommendations for WDFG

As with all companies, for the challenge of Sustainable Development to be met, WDFG will be required to expand on the traditional approach to business of simple profit-maximisation, and seek to further embed sustainability principles into its operations. In doing so, it must seek commercially, sustainable, business models that maximise profit in ways that improve its own environmental performance, and that of the wider aviation sector. In doing so the company will be able to improve airport-retailer relationships, mitigate the risks faced by all businesses from climate change, and address the specific risks posed to the sector by increased aircraft emissions and fuel costs.

In terms of WDFG's strategic goals, the researcher believes that the current three-pillar approach taken by the company (see Figure 7-3) is largely appropriate, in that it is designed to maximise revenues in a sector with a set of specific binding characteristics. That said, this strategy might benefit from the addition of a broad commitment to tackling sustainability in such a way that it becomes a central business objective. This could see the current three-pillar strategy, supplemented with a commitment to sustainability, such as in illustrated Figure 7-3 below.

The current three-pillar strategy central to WDFG operations (*WDFG, 2014b*):

- Delivering sustained growth through the travel retail sector, driven by increasing passenger numbers, increasing passenger spend and the emergence of new duty free markets.
- Creating and retaining close working relationships with airports and brand partners to create exciting and innovative environments, and to display brands.
- Maintaining a stronghold position in three key markets; the UK, Spain and the USA.

Potential new strategy to guide the company going forwards:

- Ensure sustainable growth by developing business models that support key aviation stakeholders, and the travelling public, to meet the challenges posed by energy and climate change.

Figure 7-3; An example of how current WDFG strategy could by modified to maintain current objectives, but in ways that are commensurable to the challenges of Sustainable Development.

As detailed in Table 7-2 at the start of this chapter, evidence of Bocken *et al.* (2014) sustainable business model archetypes are already found in the wider retail sector – typically as ancillary activities that supplement the main objective of selling products to customers. Such retailers do however differ from WDFG in that they are not confined to a particular location, certainly not with the same level of operational and regulatory constraints as the airport. This means that business model innovations that may be suitable for other retailers, are less valid, or impossible options for WDFG.

In this context, this research suggests that in the short-term the most suitable of the eight sustainable business models put forward by Bocken *et al.* (2014), is the ‘Maximise Resource and Energy Efficiency’ archetype. This enables the business to continue to focus on profitability through the sale of goods to passengers - an activity that the business is highly optimised towards achieving, and is considered by passengers to be an expected provision in the airport. Furthermore, this archetype is able to deliver carbon savings that directly benefit the aviation sector - i.e. emissions related to both WDFG, airports, and airlines. Additionally, it is through this business model innovation that WDFG may be able to deliver carbon and economic savings for airlines by reducing the weight taken onto aircraft.

Incremental change towards sustainability (i.e. based around the incumbent WDFG business model), can be justified in as much as it complies with the theories of the likes of Natrass and Altomare's (1999) Natural Step Framework. As stated in literature review, this advocates that sustainability goals can be achieved through step changes, rather than through radical innovations alone. By implementing incremental change, the company is able to constantly move towards some vision of sustainability following 'first order principles; that is, addressing core principles first, as the logical starting point for action in a given area, and then moving into more advanced areas as skill sets are developed (Natrass and Altomare, 1999).

It should be noted that the types of innovations identified as inappropriate for WDFG also remain sparse in the wider retail sector, with businesses that do engage in such activities being very much outliers in this regard. Furthermore, and as stated above, these solutions are typically supplementary activities to the main objective of selling goods to customers, rather than being the central business model around which an organisation is focused. As listed below for example the Marks and Spenser Sustainability Plan (M&S, 2015) demonstrates a number of Bocken *et al.* (2014) archetypes - however all of these are secondary aspects of a business that, like WDFG, is still rooted in the sale of goods (often premium brands) to customers on a permanent basis:

- **'Maximise resource and energy efficiency'.** A number of energy efficiency schemes have been implemented across the company.
- ***'Create Value from Waste'.*** The company has a 'Shwopping' scheme through which customers can return used items that may put back in to the production cycle.
- ***'Substitute with renewables and natural processes'***. The retail outlet at Cheshire Oaks store is constructed out of sustainable acquired timber.

- ***'Adopt a stewardship role'.*** The company work closely with its supply chain to ensure that sustainability principles are adhered to – i.e. they go beyond a basic suppliers policy.

Accordingly, it may be appropriate for WDFG to follow a similar approach, by maintaining the current business model, but seeking to implement initiatives that might continue to move the organisation towards sustainability. In doing so, the company would be showing a commitment to finding low-carbon solutions to its business activities, whilst also increasing its expertise in dealing with sustainability issues, and paving the way for more holistic sustainable business models to be progressively integrated into the organisation. A number of potential options based on Bocken *et al.* (2014) sustainable business model archetypes exist that may be implementable by WDFG in a supplementary way. For example:

- ***Substitute with renewables and natural processes***
  - Purchase renewable energy, or invest in renewable energy generating technologies.
  - Utilise more sustainable materials in the outfitting process
- ***Deliver functionality rather than ownership***
  - Investigate the potential of a rental business for high-end products.
- ***Create value from waste***
  - Further develop its existing waste management programme and engage with suppliers to promote the use of recycled and more environmentally benign materials.
- ***Adopt a stewardship role***
  - Engage with suppliers to reduce weight of packaging for goods sold, thereby reducing the weight taken onto aircraft.
  - Engage with airport partners, perhaps through the development of a global "sustainable airport retail partnership"
  - Engage with airlines to find solutions that might be beneficial to both parties, in ways that they, and the wider sector may all benefit.
- ***Resource for Society / environment***
  - Expand the company's charitable activities, and consider the potential of carbon offsetting the emissions that result from the products they sell being taken onto aircraft. Proceeds could be invested in carbon sequestration projects, climate adaptation in geographical regions that are

impacted by climate change, or in local airport communities who suffer adverse consequences from aviation[109].

By acknowledging that threats of climate change and peak oil are likely to impact not just the core business, but also the wider aviation industry, WDFG will be able to develop its own solutions to such challenges. Doing so will empower them to be able to control its own future, rather than being at the behest of other stakeholders, such as governments, airports, airlines, and aviation governing bodies that may seek to impose its own solutions to the carbon challenge. It is possible that such solutions will not be in the best interests of WDFG and lead to even greater challenges for the business in the future.

[109] Namely local air pollution, and noise disruption (Thomas, Upham and Raper, 2001).

8. Conclusions and recommendations

8.1 Introduction

This Chapter concludes the thesis by summarising the key findings from the research, setting them within a broader context, demonstrating the contribution to knowledge, highlighting recommendations in light of the research outcomes, and advising on potentially beneficial further lines of enquiry.

8.2 Summary of key findings

The aim of this research was "to investigate how airport retail business models will have to evolve in response to the challenges arising from climate change and peak oil." It accomplished this through case study research of the World Duty Free Group, which acted as the lens through which the researcher could investigate five specific research objectives.

Figure 8-1 below highlights the main research findings and recommendations for the airport retail sector, in the context of the Sensitising Framework of the research, first introduced in Chapter 2. It summarises how the sustainable development challenge that society faces poses a threat to the aviation and retail sectors. These sectors must adapt to this challenge in order to avoid constraints to growth, but also have a responsibility to contribute to efforts to overcoming such challenges. Doing so will require the implementation of low-carbon business models, the identification of which has seen the researcher make a number of recommendations. Figure 8-1 below details the research findings in the context of the research objectives, with additional information provided through Sections 8.2.1 to 8.2.5.

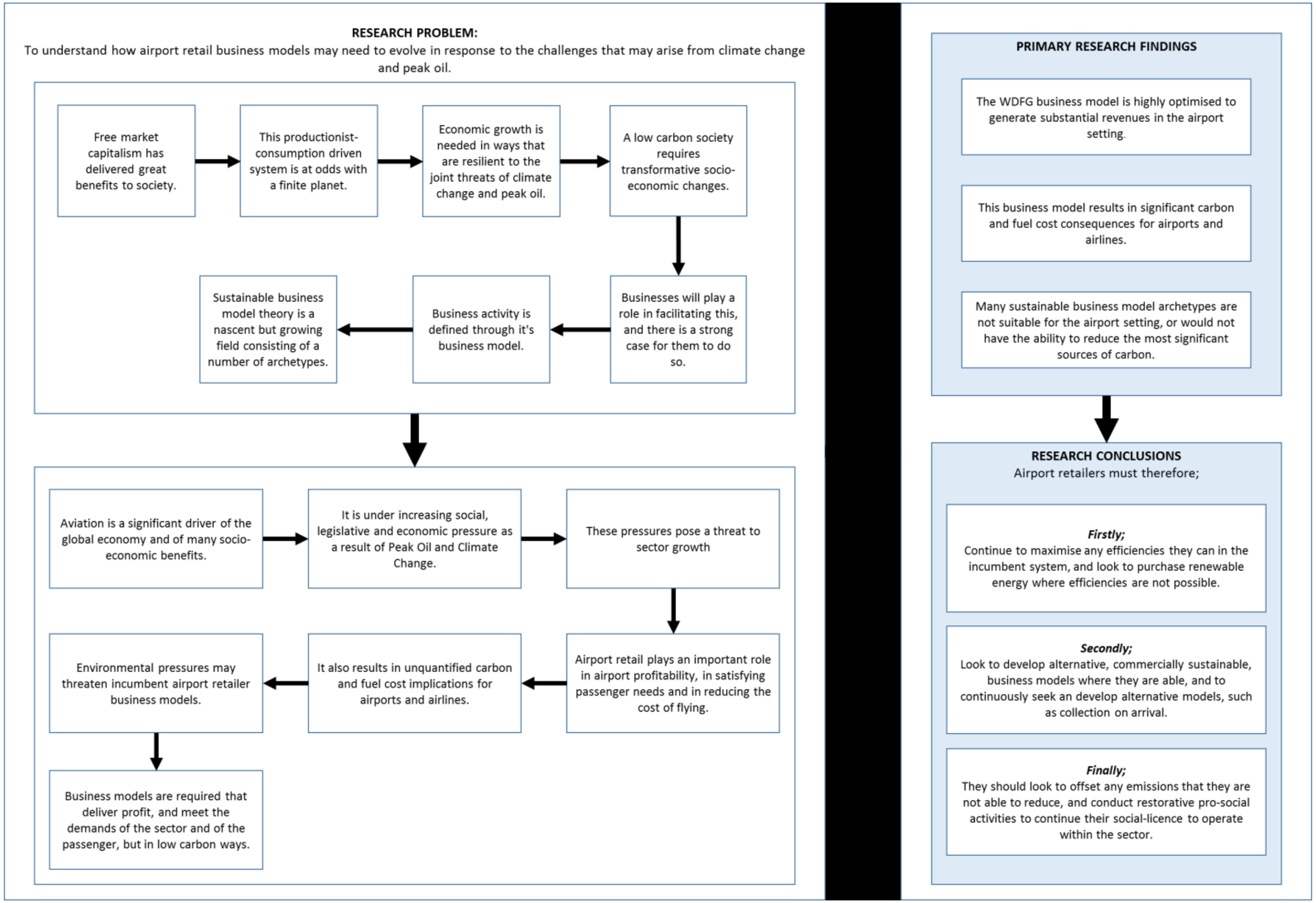

Figure 8-1; Sensitising Framework of this thesis, supplemented with the primary findings of this research, and recommendations for the airport retail sector.

Table 8-1; Summary of research findings per Research Objective		
	Description	Research Findings
Research Objective One	Understand the incumbent business model of airport retailers and identify the characteristics that differentiate the sector from other forms of retailing.	Business models are highly specialised and designed to maximise profitability in the airport setting. Whilst highly profitable, the setting constrains the sector's ability to innovate as it must conform to rigid physical, regulatory, financial, and operational constraints.
Research Objective Two	Determine the environmental impacts (carbon emissions and energy use) and resulting economic costs of airport retailer business models for airport operators and airlines.	Duty and Tax Free retailing increases carbon emissions from the operation of airports – by a total of 3,647tCO_2e in the case of WDFG operations at Manchester Airport. Whilst c.35% of CO_2 rom WDFG activity at Manchester result from retail outlets, 37% arises from additional aircraft emissions, equivalent to an additional 0.3% of aircraft carbon emissions globally which represents an additional fuel cost to airlines of £41m per year.
Research Objective Three	Clarify how the carbon emissions and fuel cost implications of airport retailers may threaten the sector in the future.	Retailers face limited short-term pressure from CO_2 emissions resulting from its business model. In the future, profitability may be negatively impacted by requirements from airport operators and particularly by pressure from airlines to reduce the amount of weight taken onto aircraft. The lack of diversification in airport retailer business models, and the constraints that limit innovation, pose a potentially significant threat to the airport retailers in the longer term.
Research Objective Four	Identify what 'Sustainable Development' might look like for airport retailers.	The particularities of the airport retail sector means that new business models must comply with a number of specific criteria that restrict opportunities for innovation. This makes innovation more difficult than in other sectors.
Research Objective Five	Understand how airport retailer business models can be adapted to the demands of a low carbon society.	The majority of the emerging sustainable business models cannot tackle the sustainability challenge for airport retailers. They are either inappropriate for the airport setting, or do not adequately tackle the primary sources of carbon from the industry (in-store energy and aircraft emissions).

8.2.1 Research Objective One; understand the incumbent business model of airport retailers and identify the characteristics that differentiate the sector from other forms of retailing.

The airport retail business model exhibited through a business model canvas exercise (Chapter 5) was identified as being illustrative of the 'master concessionaire', in which the company has been 'hired' to provide duty free and other retailing services by an airport operator (in this case study, Manchester Airport).

Like all businesses, airport retailers have the overarching objective of generating revenues for its shareholders, doing so under the neo-classical economic model (see Tomer, 1999) where short term profit-maximisation is more significant than longer term issues of sustainability. The core elements of retailer activity under this business model are all similar to those found by other 'brick-and-mortar' retailers; for example the primary objective of selling physical products, logistical delivery programmes, the presentation and promotion of products, and support provided by a sales force. For airport retailers however, the characteristics of the airport setting means that many of these activities have become highly specialised

Consumers have traditionally associated airport retailing with luxury. This, combined with the fact that passengers, typically have a psychological state of mind that is geared towards indulgence, means that airport retailers market themselves on the availability of premium branded items (at lower prices). Due to the diverse mix of passengers however, retailers must also sell low-value products. This diversity, coupled with a lack of space within the airport, and a high volume of sales requires a robust delivery system to ensure product availability. This requires frequent deliveries, and state of the art monitoring. To maximise sales to a wide range of customers, many of whom are time constrained and who are offered a diverse range of products, airport retailers also employ a larger sales force than found on the high-street. Airport retail outlets are typically found in terminal locations with limited natural lighting but require high illumination of products to maximise sales. To compound this, the diverse product mix requires a variety of temperature environments across the (typically open plan) shop floor. All of these factors have direct implications for direct energy use and carbon emissions from the sector.

Additionally, the setting means that products can only be sold to passengers on the airside of the airport. This means that duty free and tax free retailers, such as WDFG, cannot take advantage of the types of revenue streams and customer channels available in other forms of retailing such as home delivery, or longer-term mechanisms such as rental, or subscription services. These can mean that the relationships that the retailer is able to build with its passengers are restricted to the dwell time passengers have in the airport. It also means that the vast majority of items sold in such shops are carried onto aircraft.

Airport retailers have a commitment to maximise profit generation for its airport landlords, for whom they represent a key source of revenue. This gives rise to a symbiotic relationship (albeit the retailer depends on the airport much more than the airport depends on the retailer). Retailers must therefore be mindful of its airport concerns and priorities. As discussed below, this is important in terms of the increasing requirement for airport operators to reduce the carbon impacts of its operations. Given that the majority of its customers have to take their purchases onto aircraft, the airport retail sector is also dependent upon the hand baggage policies adopted by airlines.

8.2.2 Research Objective Two; determine the environmental impacts and resulting economic costs of airport retailer business models for airport operators and airlines.

A carbon footprint assessment found that WDFG activities at Manchester Airport result in emissions of 3,689 tCO_2e per year, with the majority arising from in-store energy use (35%) and increased fuel burn for airlines as a result of WDFG products being taken onto aircraft by passengers (38%).

Energy use accounts for almost 7% of Manchester Airports total energy use, whilst the logistics fleet, providing daily deliveries to all airports (plus on site vehicle movements), and a high number of staff, result in significant additional carbon emissions linked to the operation of the retail outlets.

Identifying that emissions associated with aircraft are the largest source of CO_2 is a totally new finding. It is significant as it suggests that, at a global level, airport retail activities could be contributing an additional 0.03% of airline CO_2 emissions (or c.200,000 tonnes per year) and fuel costs.

8.2.3 Research Objective Three; clarify how the carbon emissions and fuel cost implications of airport retailers may threaten the sector in the future

Air transport is coming under significant political and commercial pressure because of its growing demand for energy and because its carbon emissions are forecast to increase at a time when Governments are seeking significant reductions in CO_2 to prevent dangerous climate change.

Retailers make a small, but significant, contribution to the emissions of airport and airline operators but they can play an active role in its carbon reduction ambitions. The growing need for airport operators to reduce their relative and actual carbon impacts to ensure growth and cut operating costs will likely see airport retailers come under increasing pressure in the future. A good example of this situation is provided by Stockholm Arlanda Airport in Sweden where future airport growth is directly tied to a carbon limit (Swedavia, 2013).

Of greater threat to airport retailers is the impact that their current business models have on aircraft fuel burn and therefore emissions. In proportional terms, the aforementioned global contribution of 0.03% to aircraft carbon emissions and fuel costs may be small, but in absolute terms they are significant enough to warrant attention from airlines that are already investing significant funds to reduce on-board weight, including action which impacts upon levels of customer service (such as the one-bag rule).

For retailers such as WDFG, developing low carbon business models will not only help to mitigate risk, it may also provide competitive advantage when seeking new commercial contracts with airports.

8.2.4 Research Objective Four; identify what 'Sustainable Development' might look like for airport retailers.

Considering the specific characteristics of the airport environment, the research identified three criteria that business models in the airport retail sector must simultaneously satisfy in order to be commercially sustainable. These models must be able to:

- Sustain current revenues and support business growth (commercial sustainability);
- Fit within the specific operational and regulatory constraints of the airport (operational sustainability);
- Minimise energy use and carbon emissions for airport landlords and airlines (environmental and commercial sustainability)

Accordingly, the airport setting can be highly restrictive in terms of the ability of airport retailers to innovate. To date this has not proved a problem for the sector, as it has managed to experience consistent growth, despite changing market externalities such as the rise of Low Cost Carriers, the removal of the European Duty-Free market, and the development of new business models in other retail sectors, such digital media, as on-line shopping, and home delivery. That said, developments such as climate change and peak oil, pose emerging threats not just the continued success of airport retailer, but to the entire aviation industry.

The fact that the WDFG is rooted in the mass consumption of products – a root cause of Sustainable Development issues – means that the company current business model may be inherently unsustainable, particularly as the assets it sells (e.g. alcohol and jewellery) do not sustain life, but rather enhance it. Increasing calls in the literature for a reduction in consumption (i.e. the De-Growth movement), could see this model come under threat in the long term future, particularly as wider issues surrounding sustainable development and retail (i.e. availability of materials, volatility of prices, threat to supply chains, and changing customer demands) impact retailer supply chains. However, considering the fact that retailing in general remains popular with the public, particularly Duty-Free retailing, this suggests that such risks will not present to the industry in the foreseeable future.

Importantly, it could be argued that retailers have a requirement to continue to focus on profitability through this business model, firstly to their shareholders (to whom they are legally obliged to generate profits), and secondly to their airport landlords, to whom they contribute an essential source of revenue, that in turn means lower aeronautical charges to airlines.

Considering the scale of risk, and the lack of clear solutions, it therefore makes business sense for retailers to begin to seek out solutions to the sustainability challenge. Below, the final Research Objective outlines the specific actions that could be taken by retailers to achieve this.

8.2.5 Research Objective Five; understand how airport retailer business models can be adapted to the demands of a low carbon society.

The literature suggests that the characteristics of a sustainable business model appropriate for a low carbon society include being commercially successful (so as to generate revenue), being future ready (to be able to cope with rising, volatile energy and commodity prices), and to be part of a sustainable society (by internalising externalities, and decoupling economic performance from environmental harm). Accordingly a number of sustainable business models are emerging in the literature that adhere to these principles, with *Bocken et al.* (2014) identifying eight broad archetypes, as detailed throughout this thesis.

Considering the context of the airport setting and the criteria detailed above however, many of these archetypes have been found to be inappropriate in addressing the challenges faced by airport retailers. This is because they are either;

- Unable to generate the same revenues as the incumbent business model as they would require decrease the consumption of goods.
- Incompliant with the physical and regulatory constraints of the airport, for example the way in which WDFG must sell and deliver products within the airport, limited operating space, and frequency of visits by passengers;
- Run against current customer demands and the demands of brand suppliers; i.e. typically for high quality goods with perception of luxury – for example being made of premium, often heavy materials.
- They do not tackle the most pressing environmental issues that threaten retailers or the wider aviation sector, namely in-store energy emissions, or the weight of products taken on to aircraft.

WDFG is already addressing the first-order principles of sustainability (i.e. to maximise resource use and energy efficiency), whilst innovations that are more profound will cause major disruption to incumbent models – thus carrying great potential risk. Accordingly, the research identified that the sector will find it difficult to radically transition towards new business models that will help to deliver Sustainable Development, or to deliver substantial energy and carbon savings for the sector.

The research suggests that retailers should therefore seek to sustain revenues through its incumbent business models, whilst continuing to seek out environmental savings where possible, by implementing sustainable business models as ancillary, 'bolt-on' activities to the primary objective of selling products to passengers. For example, the company could look to expand the take up of its collection on arrival service, or look to engage with its suppliers to reduce the weight of the products it sells. In doing so it will not only be able to continue to deliver profitability and further carbon savings, it will also begin to develop appropriate networks, reputation and internal skills that will leave it well placed to take a more radical step if required in the future.

A number of sustainable business models exist that may enable airport retailers to reduce consumption that results from their business, for example product-service systems, or by switching to rental rather than purchasing of products. Indeed, when this was suggested to the organisation, it was noted that they the company have already begun internal discussions regarding the potential of renting high value jewellery or handbags to enhance the 'weekend break' experience. It is however, unlikely that these will be able to deliver the same levels of revenue that are so important for shareholders, and airport operators. Additionally, systems such as product rental would require a complete system redesign of retailers, requiring additional logistical systems to manage such schemes. This would represent risk to retailers, would likely to prove expensive, and prove less popular than existing products for the majority of passengers (and airports). Furthermore, such systems only apply to non-consumable items such as electronics and clothing apparel.

As discussed above, the principle source of energy use and carbon emissions arising from the incumbent WDFG business model arises from products taken onto aircraft. Alternative business models that would reduce these impacts would include:

- ***Home delivery;*** This is not possible due to the regulatory constraints that surround the way in which duty-free items are sold in the airport. Retailers could press for changes in these regulations, however, this would open up the market to competition (e.g. from companies such as Amazon).
- ***Collect and purchase on arrival;*** WDFG already offer this service at a number of airports, but they rely on passengers returning to the same location at which they were purchased or upon destination airports holding the same products and would be particularly difficult to operate when the duty-free concession is operated by another provider. Finally, they are believed to have a negative impact on passengers impulsiveness when making purchasing decisions.
- ***Lighter product weight;*** Directly reducing product weight would enable fuel burn reductions, at no direct loss of sales revenue for retailers. This would however face barriers due to the requirement to engaging with a large number of suppliers to request that they modify their production systems. Additionally, this could affect sales due customer expectations for luxury items to be made from premium materials.

WDFG have a programme to reduce energy use linked to its retail outlets for example through the installation energy efficient lighting and monitoring and through a world class and award winning logistics system. However, here too there are externally imposed limitations, for example from the belief that the illumination of products is key to revenue generation, particularly as many suppliers dictate the way in which products are displayed. Where it is not possible to reduce energy, retailers can purchase renewable energy (all be it that this could increase operating costs) or even invest in their own renewable energy generating plant as others are increasingly doing.

Finally, for emissions that cannot be further reduced (be this from instore activities or secondary aircraft emissions), retailers can consider investing in carbon offsetting as a way to reduce the carbon threat posed to their businesses. This research has shown that the cost of offsetting all of the aircraft emissions that result from WDFG operating in the airport would be relatively small (c. £11,000). Considering the potential risk avoidance of doing this, combined with potential reputational enhancements, it could be argued that this cost is reasonable. At the same time, retailers should be engaging with their suppliers (particularly those in the alcohol and cosmetics categories) to find ways in which products they are supplied with could be made lighter.

8.3 Contribution to knowledge

From an academic perspective, this research has investigated the ability of a major, global organisation, such as WDFG, to change to a business model that is more commensurate with a low carbon economy. The contribution falls into two areas.

First, a contribution was made to the academic literature of business and sustainability by virtue of applying Osterwalder and Pigneur's (2010) business model canvas to a sector where the it had not previously been applied. Additionally, the f Bocken *et al.* (2014) sustainable business model archetypes were applied to the airport retail sector, representing the first attempt at assessing the suitability of these archetypes in a specific industry.

Second, there is a contribution to the wider academic and practice literature on sustainability challenges in the airport retail sector and the aviation industry, and how these retailers might be able to transition towards the demands of a low carbon economy. Considering the importance of aviation to society and the significant role of airport retailing in the air transport system, the findings of this research could potentially have far-reaching implications for the sector.

A significant contribution was made to the literature through identification of a detailed business model used by airport retailers. Previously, the only similar attempt of defining the industry in this way was through Freathy and O'Connell's (1998) illustration of retailer activity chains, as illustrated in Section 2.8.4 of Chapter 2. Not only is the identification of this business model a novel contribution, it also acts to brings together the multi-facet of research strands from other authors in the airport retail literature (for example Freathy, 2004; Kim and Shin, 2001; Newman *et al*., 1994; Geuens, 2004; Wagner, 2008), to create a more holistic picture of the industry.

One of the most important contributions of this research has been quantification of the impacts of airport retail in terms of energy use and carbon emissions associated with the air transport sector. Firstly, calculations in Chapter 6 found that retail activities make a significant contribution to CO_2 emissions associated with the operation of airports, and by acting to reduce these emissions, retailers may be able to help airport operators achieve their carbon reduction (sustainability) objectives. Secondly, the research identified that the single biggest source of carbon emissions associated with airport retail operations arose from products bought in retail outlets being taken onto aircraft. Set in context, the additional CO_2 emissions from aircraft was however, on a global perspective, significant but comparatively small (c.0.03%). This is, however, nonetheless, a large quantity of CO_2 generated by the air transport industry that is not essential for aviation mobility to be facilitated. As such this could be used by those with a vested interest in reducing aviation carbon emissions to make the case that such emissions are unnecessary, and should be reduced.

The research also identified that whilst the sector's contribution to additional airline spend on jet fuel is small in proportional terms, it can nonetheless be measured in the tens of millions of pounds globally. This suggests that airport retailers could face significant pressure in the future as airlines continually look to reduce operating costs.

The research analysed the business model of WDFG in light of the carbon threat, and ascertained that in its current state, it is not equipped to meet the requirements of a low-carbon society. The sector is inherently consumption driven, and the emissions that result from products being taken onto aircraft do not exist in other forms of retail.

The specific airport business environment in which WDFG operates also creates significant constraints upon the ability of the organisation to change its current business model into one that is more appropriate to a low carbon economy. Indeed, the commercial success demonstrated by WDFG has arisen from the fact that its business model is highly attuned to the commercial environment in which it operates. It may be, however, that this high degree of specialisation also makes it more difficult for the organisation to adapt to the environmental challenges that are starting to impact upon the air transport industry and therefore threaten its own growth in the longer term.

A further novel contribution from the research arose from the use of Boardman, Shapiro, and Vining's (2004) Compressive Strategic Analysis framework. This framework is rarely cited in the literature, and its use in this research represents a rare occasion for its application to be documented. The research also added to the literature surrounding this framework by using it in the context of Sustainable Development. This saw the researcher adapt the framework to identify the call to action for a firm from a sustainability perspective. This resulted in the researcher bring together a number of tools and concepts within the framework, namely; the business model canvas, carbon accounting through the GHG Protocol Guidance, and the Bocken *et al.*, (2014) sustainable business model archetypes.

These contributions are summarised in Table 8-2 below.

Table 8-2; Key contributions to theory arising from this research	
Key Findings	Contributions to Theory
Research Objective 1; Understand the incumbent business model of airport retailers and identify the characteristics that differentiate the sector from other forms of retailing.	The research represents the first application of Osterwalder and Pigneur's (2010) Business Model Canvas (BMC) in the airport retail sector. Combined with the work of Kalakou and Macario (2013), this has helped to develop a greater understanding of the airport operating environment, and associated business models. Airport retailing was identified as highly constrained by the airport, requiring specialisation on this setting in order operate effectively and deliver commercial success. The development of a business model of airport retailing means the different literature streams surrounding the sector can now be integrated into a framework that describes the entire sector.
Research Objective 2; Determine the environmental impacts and resulting economic costs of airport retailer business models for airport operators and airlines.	This is the first research to quantify the fuel burn impacts of airport retail sales being taken onto aircraft; in doing so, the findings identify potentially significant in the long term risk to the sector. This has implications for the academic literature (in terms of efforts to understand and quantify aircraft fuel burn) and practice literature (in terms of the aviation sectors ability to respond to the climate challenge). The research has shown that the Cost of Weight Formula (see AITO,2012) is a simple yet accurate way to quantify the fuel burn impact of duty-free items being taken onto aircraft, enabling retailers to calculate wider carbon impacts of their business models in the future.
Research Objective 3; Clarify how the carbon emissions and fuel cost implications of airport retailers may threaten the sector in the future.	This study represents the first investigation into the threat posed to airport retailers by the Sustainable Development challenge. Considering the importance of aviation to society, and the important role of retailing in supporting airport operator revenues, this is a significant contribution both academically and to the practice literature.
Research Objective 4; Identify what 'Sustainable Development' might look like for airport retailers.	Contribution to the academic and practice literature regarding the specific case of airport retailing, in terms of the requirements for the industry to generate revenue for shareholders and airports, be logistically feasible considering the characteristics of the airport, reduce company and airport emissions, and reduce the emissions and fuel costs of airlines.
Research Objective 5; Understand how airport retailer business models can be adapted to the demands of a low carbon society.	This research represents the first time that Bocken *et al*. (2014) sustainable business model archetypes have been analysed from the perspective of a particular sector, identifying that the emerging archetypes are not fully applicable in all situations. Additionally, the research supports the theories surrounding the difficulty in the diffusion of innovations (see Penna and Geels, 2012) by identifying that incumbent organisations are so entrenched in current systems that innovation is difficult to implement, and may face resistance from firms which may see the call for change fraught with risks. Finally, the research has made a contribution to the practice literature by making recommendations on how the airport retail sector may be able to overcome the sustainability challenges in ways that are able

	commensurable with the physical setting of the airport, and the aviation industry.

8.4 Research critique and further lines of enquiry

The data generated through this research is of relevance to a much wider research setting, relating to the ability of major organisations across every sector of the economy to adapt their existing business models to the challenges of sustainable development and in particular peak oil and climate change. That said, the addition of further case studies (retailers) could have potentially delivered more representative results. This is particularly the case if retailers in different parts of the world had been included - given that they differ in terms of the types of products they sell, the types of passengers who they serve, and in their business models and operational practices. By focusing solely on WDFG, the research assumes that all airport retailers operate similar business models, when in reality the different characteristics and requirements of operating in different markets means that these business models may differ from location to location. As discussed previously, Heinemann Duty Frees' highly controversial home delivery offer is an example of this – something that WDFG have not considered appropriate for their own business – or indeed for the wider sector. This has potentially limited the transferability of the research findings to other retailers – particularly in terms of the ideation of potential new business models.

Furthermore, the research could have expanded the scope of its single case study setting, to, for example, include the entirety of its supply chain, i.e. product manufacture, and delivery to the company. This would have provided a more complete picture of the organisations environmental implications, however, the researcher believed that, considering that such factors are of little consequence to the wider challenges facing the aviation sector, these would have been out of the scope of the project.

The research could also have been enhanced by considering different customer attitudes towards alternative business models and their implications for product sales. For example, the acceptability of lightweight plastic packaging in high-quality goods, or an enforced collection on arrival system. Doing so would have given the researcher greater insight into the potential of such approaches.

All of these limitations are potential avenues for future research to take place. Additionally, research could consider the appropriateness of alternative business models, from the perspective of customers. For example, it could investigate small changes to current operations (i.e. collection on arrival, or the sale of premium products in plastic packaging) or radical step changes to the entire business model, such as the implications of moving away from a consumption based business model, to services such as product leasing or carbon offsetting.

The research also did not consider (again due to logistical limitations) the environmental consequences of products after arrival at destination airports. For example, the energy usage of electrical products, and the waste disposal of other items. This would represent a project with a potentially radical different scope to the present research, but could have potentially significant implications in terms of the company's overall environmental impact – and the identification of potential solutions. For example, are there products disposed of at the airport that could be collected and provided to local businesses operating in the area, as per the requirements of a circular economy?

Given the inter-relationships and tensions that exist between the operations and commercial interests of different service partners (the airport operator, the airport retailer and airlines) , future research could investigate airport retailing from a holistic, sector-wide level, investigating opportunities for greater integration of business models or activities, to deliver environmental and commercial sustainability and create resilient to the carbon threat.

The implications of policy change could also be the focus of further research, namely changing the regulations around the way in which retailers sell duty free products. Loosening current legislation could potentially lead to products being sold at airports, but collected at local supermarkets or other retailers, hence reducing weight taken onto aircraft – although as this research has shown, doing so may open up the market to new entrants that may pose a threat to those already embedded in the sector.

Finally, the researcher believes modification of the framework used in this research, and how Comprehensive Strategic Analysis can be adapted for sustainability, could have significant academic and practical value. The framework used in this particular setting proved to be of great help to the researcher in meeting his research ambitions and further testing and adaptation in other research settings could see the development of a powerful tool to help drive sustainable innovation in firms the world over.

8.5 Final comments

It is becoming apparent that the current social and economic system that has evolved over the last Century is unsustainable in the context of environmental change and limited resources. The solution is not simply one of reducing environmental impacts as this does not address the need, embodied within the concept of sustainable development, of delivering wealth creation and social progress. Approaches to Sustainable Development are contested, and the challenge of meeting this aspiration is fraught with obstacles. It requires action by government, by industry and by individuals. Dramatic change is necessary, however, particularly in the context of a democratic market economy, it is difficult to envisage how change can take place. Governments require a popular mandate to regulate for change and are fearful of taking action that could have adverse economic impacts. Companies resist making changes to their business models for fear of losing market share or profitability or simply because they do not have the necessary information with which to assess risk and respond appropriately to it. Meanwhile increasing affluence across the world is driving up consumer demand not as a result of need, but rather want.

Against this background, airport retailing presents a particularly interesting case study as it not only faces the same challenges as others in the retail sector, but it is embedded in a larger industry that faces its own very significant sustainability challenges. Given the symbiosis across the different stakeholders in the aviation sector, it is impossible for one actor to take action without impacting all the others. The simple response to emissions that arise from retailing would be to remove retail outlets from airports; however the consequences of doing so would be felt across the industry; from direct and indirect employment to the cost of air tickets. This in turn would impact upon low cost flying and potentially levels of global mobility.

The onus is therefore on airport retailers to proactively respond to the emerging carbon challenge and, working with its aviation services partners identify appropriate business models that will enable profitability to be maintained, but in low-carbon ways. This research has shown that no single sustainable business model archetype may be able to achieve this, however retailers may be able to significantly reduce the impact of their operations through a number of ancillary innovations additional to the main activity of selling products to customers. The research has also demonstrated that if the challenge of carbon reduction is to great that it would cost relatively little for the sector to offset the emissions that remain. This suggests that the carbon challenge facing the sector, although difficult, is not insurmountable. By taking action now to identify, develop and test sustainable innovations, airport retailers will be able to develop long-term solutions to the carbon threat, on their own terms, that will enable this profitable, and much appreciated sector to remain part of the travelling experience for the longer term.

9. Bibliography

Accenture (2012) Sustainable Energy for All; Opportunities for the Retail Industry. Available Online; http://www.accenture.com/us-en/Pages/insight-sustainable-energy-retail-industry.aspx [Accessed; 15/02/2013]

AGIFORS (2011) Operations Control – May 2011. Available On-line; www.agifors.org/document.go?documentId=2131&action=download [Accessed; 14/07/2015].

Air Transport Action Group (2015) Facts and Figures. Available online; http://www.atag.org/facts-and-figures.html [Accessed; 30/07/2015].

Airbus (2015) Flying By Numbers 2015-2034. Global Market Forecast Available On-Line; http://www.airbus.com/company/market/forecast/ [Accessed; 14/11/2015]

Airbus (2015) New Airbus aircraft list prices for 2015. Available online; http://www.airbus.com/presscentre/pressreleases/press-release-detail/detail/new-airbus-aircraft-list-prices-for-2015/ [Accessed; 25/05/2015].

Airports Commission (2013) Aviation Connectivity and the Economy. Available Online; https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/138162/aviation-connectivity-and-the-economy.pdf [Accessed; 14/09/2014]

AITO (2012) The one-stop Aircraft Operation Solutions. Aircraft IT Operations. V1.5 Spring 2012. Available On-line; http://issuu.com/magazineproduction/docs/aircraft_it_ops_issue_5_for_ezine/20 [Accessed; 14/07/2015]

Amit, R., and Zott, C. (2010) Business Model innovation: creating value in times of change. IESE Business School Working Paper WP-970, July 2010 Available On-line; http://www.iese.edu/research/pdfs/di-0870-e.pdf [Accessed; 2/07/2014]

Applegate, L. M., ed., "E-Business Models: Making Sense of the Internet Business Landscape." In *Information Technology and the New Enterprise: Future Models for*

Managers, edited by L. M. Applegate, Gary W. Dickson, and Gerardine DeSanctis. Upper Saddle River, NJ: Prentice Hall, 2000.

Arksey, H. & Knight, P., (1999), *Interviewing for Social Scientists: An introductory Resource with examples*. Sage Publications: London UK

ATAG (2012) Beginner's Guide to Aviation Efficiency. Air Transport Action Group, November, 2010. Available On-line; http://www.atag.org/our-publications/latest.html [Accessed; 17/04/2014]

ATAG (2013) Facts and Figures. Air Transport Action Group. Available On-line; http://www.atag.org/facts-and-figures.html [Accessed; 01/08/2014]

Bakan, J (2004) *The Corporation; The Pathological Pursuit of Profit and Power*. Simon & Schuster, London.

Baldwin, J., & Lin, Z. (2002). Impediments to advanced technology adoption for Canadian manufacturers. *Research Policy*, 31,1, 1–18.

BBC (2007) One-bag air travel rule relaxed. BBC. Available On-line; http://news.bbc.co.uk/1/hi/uk_politics/7093795.stm[Accessed; 24/02/2013]

BBC (2013) What is fracking and why is it controversial? http://www.bbc.co.uk/news/uk-14432401 [Accessed; 17/09/2014]

Beckerman, W. (1974) *In Defence of Economic Growth.* Jonathan Cape, London.

Benbasat, I. and Zmud, R (1999) Empirical Research in Information Systems: The Practice of Relevance" in *MIS. Quarterly*, 23,1, 3-16.

Besanko D., Dranove D., Schaefer S. (2007) *Economics of strategy*, 4th edition. John Wiley & Sons. Chichester

Bia, Y. (1996) The international duty free market. *Travel and Tourism Analyst*, 6, 37– 63.

Birkin, F., Cashman, A., Koh, S. and Liu, Z. (2009) New sustainable business models in China. *Business Strategy and the Environment,* 18, 1, 64–77.

Boardman, A. E., Shapiro, C.M., Vining, R.A. (2004) A framework for comprehensive strategic analysis. *Journal of Strategic Management Education* 1,2.

Bocken, N.M.P., Short, S.W., Rana, P. Evans, S. (2014) A literature and practice review to develop sustainable business model archetypes. *Journal of Cleaner Production* 65, 42-56.

Boeing (2015) Long-Term Market. Current Market Outlook 2015-2034. Available On-Line; http://www.boeing.com/commercial/market/long-term-market/ [Accessed; 14/11/2015]

Boons, F. & Lüdeke-Freund, F. (2013): Business models for sustainable innovation: state-of-the-art and steps towards a research agenda. *Journal of Cleaner Production,* 45, Aprile 2013, 9–19.

Boons, F., Montalvo, C., Quist, J. and Wagner, M. (2013) Sustainable innovation, business models and economic performance: an overview, Journal of Cleaner Production, Volume 45, April 2013, Pages 1-8.

Bork, A. (2006) Developing a retail marketing strategy to promote both airport and retailers, *Journal of Airport Management*, 1, 4, 348-56

Branquinho, S. (2010) One bag rule severely impacting retail revenues. Available On-line; http://www.airport-business.com/2010/07/one-bag-rule-severely-impacting-retail-revenues/ [Accessed; 14/05/2014].

Brewerton, P., and Millward, L. (2001) *Organisational Resarch Methods: A guide for researchers and students.* Sage, London.

Bridgman, H. (1990) *Global Air Pollution; Problems in the 1990s*. Belhaven Press, London.

Brown, H.S. and Vergragt, P.J. (2015) From consumerism to wellbeing: toward a cultural transition? *Journal of Cleaner Production*. Article in Press. Available online 12 May 2015, ISSN 0959-6526, http://dx.doi.org/10.1016/j.jclepro.2015.04.107.

Bryman, A. (1989) *Research Methods and Organizational Studies.* Routledge, London.

BSI (2001) Specification for the assessment of the life cycle greenhouse gas emissions of goods and services. Available On-line; http://shop.bsigroup.com/upload/shop/download/pas/pas2050.pdf [Accessed; 01/04/2014]

Burritt, R., Hahn, T. and Schaltegger, S. (2002), *Towards a Comprehensive Framework for Environmental Management Accounting. Links between Business Actors and Environmental Management Accounting Tool*", Australian Accounting Review, July

CAA (2013) Assessment of Commercial Revenues at Heathrow Airport. Final Report . March 2013. Available On-line; http://www.caa.co.uk/docs/78/HeathrowFinalReport_Redacted.pdf [Accessed; 01/09/2015]

Calder, S (2006) *No frills: the truth behind the low-cost revolution in the skies.* Virgin Books, London.

Carbon Trust (2007), *Carbon Footprint Measurement Methodology*, Version 1.1.

Carson, R. (1962) *Silent Spring, 40th anniversary edition.* Houghton Mifflin, Boston.

Charter, M., Clark, T. (2007) Sustainable Innovation: Key conclusions from Sustainable Innovation Conferences 2003–2006 organised by The Centre for Sustainable Design. *The Centre for Sustainable Design University College for the Creative Arts*. May 2007.

Chesbrough, H. (2003) *Open innovation: The new imperative for creating and profiting from technology*. Harvard, MA: Harvard Business School Press.

Chesbrough, H. (2006a) *Open Innovation; The New Imperative for Creating and Profiting from Technology.* Harvard Business School Press, Boston.

Chesbrough, H. (2006b) *Open Business Models; How to Thrive in the New Innovation Landscape*. Harvard Business Press, Boston.

Chesbrough, H. (2010) Business Model Innovation: Opportunities and Barriers. *Long Range Planning,* 43, 2010, 354-363.

Chiesa, V., & Frattini, F. (2011). Commercializing technological innovation: Learning from failures in high-tech markets. *Journal of Product Innovation Management*, 28,14, 437–454.

Christensen, C.M. (1997) *The innovators dilemma: when new technologies cause great firms to fail.* Harvard Business Review

Climate Change Commission (2015) Carbon Budgets and targets. Available Online; https://www.theccc.org.uk/tackling-climate-change/reducing-carbon-emissions/carbon-budgets-and-targets/ [Accessed; 31/10/2014].

Cohen, L. (2004) *A consumers' Republic: The Politics of Mass Consumption in Post War America.* Vintage Books, New York.

Coles, T. Fenclova, E., Dinan , C. (2013) *Tourism and Corporate Social Responsibility: A critical review and research agenda.* Centre for Sport, Liesure, and tourism Research. University of Exeter Business School.

Cook, J., Nuccitelli, D., Green, S.A., Richardson, M., Winkler, B., Painting, R., Way, R., Jacobs, P. and Skuce, A. (2013) Quantifying the consensus on anthropogenic global warming in the scientific literature. *Environmental Research Letters,* 8, 2.

Cooper, R. G. (2011). Perspective: The innovation dilemma: How to innovate when the market is mature. *Journal of Product Innovation Management,* 28, 1, 2–27.

Crawford, G., Melewar, T.C. (2003). The importance of impulse purchasing behaviour in the international airport environment. *Journal of Consumer Behaviour*, Vol. 3, Issue 1, pp. 85-98.

Crotty, M. (1998). *The Foundations of Social Research: Meaning and Perspective in the Research Process.* Sage Publications, London.

Dallen, J.T. (2005) Shopping tourism, retailing, and leisure. Channel View Publications, Clevedon

Darke, P., Shanks, G., & Broadbent, M. (1998). Successfully completing case study research: Combining rigour, relevance and pragmatism. *Information Systems Journal*, 8, 4, 273-289.

Decrop, A. (1999) Triangulation in qualitative tourism research, *Tourism Management*, 20, 1, February 1999, 157-161.

DEFRA (2009) Transformative Innovation; Report to Defra on transformative innovation. Available Online; http://randd.defra.gov.uk/Default.aspx?Menu=Menu&Module=More&Location=None&Completed=0&ProjectID=16756 [Accessed; 23/03/2014].

DEFRA (2011) Guidance on applying the Waste Hierarchy. June 2011. Available On-line; https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/69403/pb13530-waste-hierarchy-guidance.pdf [Accessed; 17/06/2015]

DEFRA (2015) Government conversion factors for company reporting. Department for Environment, Food and Rural Affairs. Available On-line; http://www.ukconversionfactorscarbonsmart.co.uk/ [Accessed; 04/04/2015]

Department for Transport (2011) Personal Travel Factsheet. Commuting and Business Travel Available On-line; https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/230553/Commuting_and_business_travel_factsheet___April_2011.pdf [Accessed; 21/08/2014].

D'Este, P., Iammarino, S., Savona, M., & von Tunzelmann, N. (2012). What hampers innovation? Revealed barriers versus deterring barriers. *Research Policy*, 41, 2, 482–488.

Diamond, J. (2005) *How Societies Choose to Fail or Succeed*, Penguin Books.

DIY (2015) Street Club: Streetclub has joined forces with Streetbank. DIY. Available On-line; http://www.diy.com/corporate/community/streetclub [Accessed 09/04/2015].

Doganis, R., (1992) *The Airport Business.* Routledge, New York

Doganova, L Eyquem-Renault, M (2009) What do business models do?: Innovation devices in technology entrepreneurship, *Research Policy*, 38, 10, 1559-1570.

Doran, P.T., Zummerman, M. K. (2009) Examining the Scientific Consensus on Climate Change. *American Geophysical Union*. 20 January 2009.

Dufry (2014) Dufry Annual Report 2014. Available On-line; http://www.dufry.com/idc/groups/dufry_investors/documents/dfy_en/dufry_annual_report_2014_compl.pdf [Accessed; 14/07/2015]

Dyllick T., Hockerts, K. (2002) Beyond the business case for corporate sustainability. *Business Strategy and the Environment*. 11, 2, 130-141.

Easterby-Smith, M., Burgoyne, J., Araujo, L. (1999) *Organizational Learning and the Learning Organization: Developments in Theory and Practice.* London: SAGE.

Eisenhardt, K. M. (1989). Building theories from case study research. *Academy of Management Review*, 14, 4, 532-550.

Ekins, P (1999) *Economic growth and environmental sustainability: the prospects for green growth.* Routledge, London

Elkington, J. (1994) "Triple Bottom Line". The Economist. November 17, 2009. Available On-line; http://www.economist.com/node/14301663 [Accessed; 24/02/2013]

Ennen, E., Richter, A. (2010) The Whole Is More Than the Sum of Its Parts− Or Is It? A Review of the Empirical Literature on Complementarities in Organizations. *Journal of Management*. 36, 1, 207-33.

Eurocontrol (2013) Challenges of Growth 2013 Task 4: European Air Traffic in 2035. Available On-line; https://www.eurocontrol.int/sites/default/files/article/content/documents/official-documents/reports/201306-challenges-of-growth-2013-task-4.pdf [Accessed; 21/10/2014]

European Commission (2015) The EU Emissions Trading System. Available Online; http://ec.europa.eu/clima/policies/ets/index_en.htm [Accessed; 21/08/2014].

Everett, R.M. (2003) *Diffusion of innovations.* Fifth edition. Simon & Schuster, London.

FAA (2005) *Aviation & Emissions; A Primer*. Federal Aviation Administration

Farquhar, J.D. (2012) *Case Study Research for Business*. Sage, London.

Fernie, J. (1995). 'The coming of the fourth wave: new forms of retail out-of-town development', *International Journal of Retail & Distribution Management*, 23, 1, 4 – 11.

Fien, J., Maclean, R., Park, MG., (2009) *Work, Learning and Sustainable Development: Opportunities and Challenges*. Springer

Fischer, K., Schot, J. (1993) *Environmental strategies for industry: International perspectives on research needs and policy implications*. Island Press, Washingto (DC).

Fitzgerald, B. & Howcroft, D (1998). Competing dichotomies in IS research and possible strategies for resolution. In: *Proceedings of the international conference on Information systems* (ICIS '98). Association for Information Systems, Atlanta, GA, USA, 155-164.

Flick, U (1998) *An Introduction to Qualitative Research*, London, Sage

Flowerdew, R., Martin, D. (2005) *Methods in human geography; A guide for students doing a research project.* 2nd Edition. Pearson, Essex.

FORA (2010): *Green business models in the Nordic Region – A key to promote sustainable growth*. Green Paper for the Nordic Council of Ministers

Forum for the Future (2011) Characteristics of a sustainable business model. Available Online; https://www.forumforthefuture.org/blog/characteristics-sustainable-business-model [Accessed; 15/07/2014]

Freathy, P. (2004) The Changing Airport Environment: Past, Present and Future Imperfect? In: Lumsdon, L and Page, S.J. (eds) 2004. *Tourism and Transport: Issues and Agenda for the New Millennium*. Oxford: Elsevier

Freathy, P. (1998) *European airport retailing: growth strategies for the new millennium.* Basingstoke, Macmillan Press.

Freathy, P., O'Connell, F. (2012): Spending time, spending money: passenger segmentation in an international airport. *The International Review of Retail, Distribution and Consumer Research*, 22, 4, 397-416.

Freathy,P. and O'Connell,F. (2000) Market segmentation in the European airport sector, *Marketing Intelligence* & Planning, 18, 3, 102 – 111.

Freeman, C (1984) *Long Waves in the World Economy*. Frances Pinter. London.

Freeman, C., Perez, C., 1988. Structural crisis of adjustment, business cycles and investment behaviour. In: Dosi, G., Freeman, C., Nelson, R., Silverberg, G., Soete, L. (Eds.), *Technical Change and Economic Theory*. Pinter, London.

Friedman, M. (1962) *Capitalism and Freedom*. Chicago: University of chicago Press

Friedman, M. (1967) The Monetary Theory and Policy of Henry Simons. *Journal of Law and Economy*. Oct. 1967, 10, 1-13.

GAIP (2015) Glossary. Global Airline Industry Program. Airline Data Project. Massachusetts Institute of Technology. Available On-line; http://web.mit.edu/airlinedata/www/Res_Glossary.html [Accessed; 17/07/2014]

Gatigon, H., Tushman, M., Smith, W., Anderson, P. (2002) A Structural Approach to Assessing Innovation: Construct Development of Innovation Locus, Type and Characteristics. *Management Science*, 48, 9, 1103-1122.

Gaziulusoy, I. & Twomey, P. (2014) E*merging Approaches in Business Model Innovation Relevant to Sustainability and Low-carbon Transitions*. University of Melbourne. Working paper for the Visions & Pathways project, August 2014.

Geels, F., and C.C.R. Penna (2015) Societal problems and industry reorientation: Elaborating theDialectic Issue LifeCycle (DILC) model and a case study of car safety in the USA (1900–1995) *Research Policy* 44, 2014, 67–82

Gelissen, J. (2012) *Qualitative Research Methods*. Second Edition. SAGE, London.

Geuens, M., Vantomme, D., Brengman, M. (2004) Developing a typology of airport shoppers. *Tourism Management*, 25, 2004, 615-622.

Gibbs, A., (1997) Focus Groups. *Social Research Update*, 19, 1-7.

Graedel, T.E., Allenby, B.R. (1995) *Industrial Ecology*. Prentice Hall, New Jersey.

Graham, A. (2008). *Managing Airports: An international perspective,* Third Edition. Oxford Butterworth - Heinemann.

Grant, R.M.(2013) *Contemporary Strategy analysis.* 8th Edition. Blackwell Publishing, Chichester.

Gray, D.E. (2013) *Doing Research in the Real World*. Third Edition. Sage, London.

Grubb, M., Brack, D., Vrolijk, C. (1999) *The Kyoto protocol: a guide and assessment.* Royal Institute of International Affairs, London, 1999.

Guiltinan, J., 2009. Creative destruction and destructive creations: environmental ethics and planned obsolescence. *Journal of Business Ethics*, 89, 1, 19-28.

Hart, S.L., Milstein, M.B., 1999. Global sustainability and the creative destruction of industries. *Sloan Management Review,* 41, 23-33.

Hartman, P.M., Zaki, M., Feldmann, N., Neely, A. (2014) Big Data for Big Business? A Taxonomy of Data-driven Business Models used by Start-up Firms. Working Paper, University of Cambridge. Available On-line; http://www.cambridgeservicealliance.org/uploads/downloadfiles/2014_March_Data%20Driven%20Business%20Models.pdf [Accessed; 01/04/2015].

Hawkden, P., Lovins, A.B., Lovins, L.H. (1999) *Natural Capital; the next industrial revolution.* Rocky Mountain Institute, Snowmass.

Hawken, P. (2010). The *ecology of commerce: A declaration of sustainability* (2nd ed.). New York, HarperCollins.

Hax, A.C., and Majluf, N.S. (1983) The Use of the Industry Attractiveness-business Strength Matrix in Strategic Planning. *Interfaces*, 13, 2, 54-71.

Heathrow Limited (2015) Results for the year ended 31 December 2014. Available Online; http://www.heathrowairport.com/static/HeathrowAboutUs/Downloads/PDF/Heathrow-(SP)-Limited-2014-results.pdf [Accessed; 01/03/2015]

Heinemann (2015) Corporate Responsibility Report. Available On-line; http://www.gebr-heinemann.de/en/download/16179/eng-GB [Accessed; 14/07/2015]

Henriksen, K., Bjerre, M., Bisgaard, T., Almasi, A.M., Damgaard, E. (2012) *Green Business Model Innovation - Business case study compendium. Empirical and literature studies*. Nordic Innovation Report 2012:20. October 2012

Hewitt-Dundasn N. (2006). Resource and capability constraints to innovation in small and large plants. *Small Business Economics*, 26, 3, 257-277.

Hobson, J.S.P. (2000) Tourist shopping in transit: The case of BAAPK. *Journal of Vacation Marketing*, 6 2, 170-83.

Hoffman, A., & Bazerman, M. H. Organizations and the Sustainability Mosaic: Crafting Long -Term Ecological and Societal Solutions. In S. Sharma, M. Starik & B. Husted (Eds.), *New Perspectives in Research on Corporate Sustainability* (Vol. 3): Edward Elgar Publishing, 2007.

Hoffman, A.J., Bazerman, M.H. (2005*) Changing Environmental Practice: Understanding and Overcoming the Organizational and Psychological Barriers*. Working Paper No. 923 For a special issue of Journal of Social Issues. Michigan Ross School of Business

Hoggart, K., Leeds, L., Davies, A., (2002) *Researching Human Geography.* Oxford University Press.

Honkasalo N., Rodhe, H., and Dalhammar, C. (2005). Environmental permitting as a driver for eco-efficiency in the dairy industry: A closer look at the IPPC directive. *Journal of Cleaner Production*. 13, 10-11,1049–1060.

Hooper, P., Raper, D., Thomas, C., (2010) Air Transport in an Environmentally Constrained World. *Journal of Airport Management*, 5, 1, 4-6.

Hooper, P. and Thomas, C.S (2013) Sustainable Development and Environmental Capacity of Airports. In: *Airport Operations* (2013). Eds; Ashford, N.J., Stanton, H.P.M., Moore, C.A., Coutu, P., Beasley, J.R. McGraw Hill, USA

Hooper, P.D. & Preston, H. (2008) *Carbon Neutral Airports and Carbon Offsetting.* OMEGA Project Report, MMU, December 2008.

Hopkins, R. (2008) *The Transition Handbook; From oil dependency to local resilience.* Chelsea Green Publishing, Vermont

Hubbert, M.K., (1956). Nuclear energy and the fossil fuels. *American petroleum institute drilling and production practice,* Proceedings of Spring Meeting, San Antonio.

Hudson, P. (1992) *The Industrial Revolution*. Hodder Arnold, London.

IATA (2011) *Guidance material and best practices for fuel and environmental management*. 5th Edition. October 2011

IATA (2014) Economic performance of the airline industry. Available On-line; https://www.iata.org/whatwedo/Documents/economics/IATA-Economic-Performance-of-the-Industry-end-year-2014-report.pdf [Accessed; 07/07/2015].

IATA (2014) Economic Performance of the Airline Industry. Available Online; https://www.iata.org/whatwedo/Documents/economics/IATA-Economic-Performance-of-the-Industry-end-year-2014-report.pdf [Accessed; 22/10/2014]

ICAO (2012) Action Plan of Sweden. With reference to Resolution A37-19 – Climate change. June 2012. Available Online; http://www.icao.int/environmental-protection/documents/actionplan/swedenrepublic_actionplan.pdf [Accessed; 14/08/2014].

ICAO (2014) ICAO Carbon Emissions Calculator Methodology Version 7. June 2014. Available On-line; http://www.icao.int/environmental-protection/CarbonOffset/Documents/Methodology%20ICAO%20Carbon%20Calculator_v7-2014.pdf [Accessed; 05/05/2015].

ICAO (2015) Carbon Emissions Calculator. Available On-line; http://www.icao.int/environmental-protection/CarbonOffset/Pages/default.aspx [Accessed; 01/04/ 2015].

ICCT (2015) Fuel efficiency trends for new commercial jet aircraft: 1960 to 2014. The International Council on Clean Transportation. Available Online; http://theicct.org/fuel-efficiency-trends-new-commercial-jet-aircraft-1960-2014 [Accessed; 10/09/2015.]

IEA (2007) Mind the gap: Quantifying Principal-Agent Problems in Energy Efficiency. International Energy Agency. Available online;

https://www.iea.org/publications/freepublications/publication/mind_the_gap.pdf [Accessed; 10/02/2015]

Index 2014. Price Waterhouse Cooper Available On-line; http://www.pwc.co.uk/assets/pdf/low-carbon-economy-index-2014.pdf [Accessed; 19/10/2014]

IPCC (2007a) Intergovernmental Panel on Climate Change. Working Group I: The Physical Science Basis of Climate Change. Cambridge University Press.

IPCC (2014) Climate Change 2014 Synthesis Report Summary for Policymakers. Intergovernmental Panel on Climate Change. Available On-line; http://www.ipcc.ch/pdf/assessment-report/ar5/syr/AR5_SYR_FINAL_SPM.pdf [Accessed; 14/07/2015].

Irrgang, M.E. (2011) *A Look at the State of Airline Fuel Conservation.* Boeing Commercial Airplanes

ISSUU (2012) A New Approach. *Aircraft IT Operations*. V1.5 Spring 2012

Jackson, T. (2009) Prosperity without Growth: Economics for a Finite Planet. Earthscan, London (2009)
Johnson, G., Whittington, R., Scholes, K. (2011) *Exploring Strategy: Text & Cases.* 9th Edition. Pearson Education Limited, Essex.

Kalakou, S., Macário, R. (2013) An innovative framework for the study and structure of airport business models. *Case Studies on Transport Policy,* 1, 1–2, 2-17.

Kallis, G., (2011) In defence of degrowth. *Ecological Economics,* 70, 2011, 873-880.

Kaplan, S. (2012). *The Business Model Innovation Factory: How to Stay Relevant When The World is Changing.* Hoboken, NJ: Wiley.

Keller, A., C. (2007). Smith versus Friedman: Markets and ethics. *Critical Perspectives on Accounting,* 18, 159–188.

Key, S. (1999). Toward a new theory of the firm: A critique of stakeholder “theory.” *Management Decision*, 37, 317-328.

Kim, H and Shin, J. (2001) A contextual investigation of the operation and management of airport concessions. *Tourism Management,* 22, 149-155

King, A.A., and Lenox, M.J. (2001) Does It Realy Pay to Be Green? An Empirical Study of Firm Environmental and Financial Performance. *Journal of Industrial Ecology*, 5 , 1, 105-116.

Kitzinger, J. (1994) the methodology of Focus Groups: the importance of interatction between research participants. *Sociology of Health and Illness*, 16, 1, 03-121.

Klein, H. K., and Myers, M. D. (1999). A set of principles for conducting and evaluating interpretive field studies in information systems. *MIS Quarterly*, 23, 1, 67-94.

Klitgaard, K.A., and Krall, L., *Ecological economics, degrowth, and institutional change,* Ecolgical Economics, 84, 247–253.

Krantz, R. (2010) A new vision of sustainable consumption, *Journal of Industrial Ecology,* 14, 7–9.

Lam, J.C., Wan, K.W., and Yang, L (2008) Sensitivity analysis and energy conservation measures implications. *Energy Conversion and Management,* 49, 3170–3177.

Larsen, P., & Lewis, A. (2007) How award-winning SME’s manage the barriers to innovation. *Creativity and Innovation Management*, 16, 2, 142-151.

Leahy, J. (2014). Global Market Forecast 2014-2033. Flying on Demand, Airbus. Available at http://www.airbus.com/company/market/forecast/. [Acc.02.01.2015]

Lederman, L.C. (1990) Assessing educational effectiveness: The focus group interview as a technique for data collection. *Communication Education*, 39, 20, 117-127.

Lee J.J., Lukachko S.P., Waitz I.A., and Schafer A. (2001) Historical and future trends in aircraft performance, cost and emissions. *Annual Review of Energy and the Environment 2001*, 26, 167–2001.

Lee, D.S., Fahey,D.W., Forster,P.M., Newton,P.J., Wit,R.C.N., Lim,L.L., Owen,B., and Sausen,R., (2009). Aviation and global climate change in the 21st century. *Atmospheric Environment*, 43, 3520–3537.

Lee, T.W. (1999) *Using Qualitative Methods in Organizational Research. Organisational Research Methods*, Sage Publications, London.

Lei, Z., and Papatheodorou, A. (2010) Measuring the effect of low-cost carriers on regional airports' commercial revenue. *Research in Transportation Economics* 26, 37-43.

Levy, M. and Weitz, B.A. (2008) *Retailing Management*. 7th Edition. McGraw-Hill Education, Columbus.

Lewis, S.L., & Maslin, M.A. (2015) Definine the Anthropocene. *Nature*. 519, 171-180.

Linder, J. and Cantrell, S. (2000) *Changing Business Models: Surveying the Landscape.* Accenture, Institute for Strategic Change. May 24, 2000.

Lovins, L.H., and Cohen, B (2012) *The Way Out: Kick-starting Capitalism to Save Our Economic Ass*. Hill and Wang; Reprint edition.

Lüdeke-Freund, F. (2013) Business Models for Sustainability Innovation: Conceptual Foundations and the case of solar energy. PhD Thesis, University of Luneburg.

Luthans, F., Hodgetts, R.M., and Thompson, K.R. (1987) *Social Issues in Business*. 5th Edition. Macmillan, New York.

M1nd-set (2014) The Travel Retail Industry's 1st Global & Cross-Category. Segmentation Study. By m1nd-set for TFWA..

Maddox, J. (1972) *The doomsday syndrome*. London: Macmillan.

MAG (2014) 2013-2014 Corporate Social Responsibility Report. Manchester Airports Group Available Online; http://www.magworld.co.uk/magweb.nsf/AttachmentsByTitle/MAG_CSR_Report_2014_v2.pdf/$FILE/MAG_CSR_Report_2014_v2.pdf [Accessed; 31/05/2015]

MAG (2014) Environment Plan. Part of the Manchester Airport Master Plan to 2030.Manchester Airports Group. Available on-line; http://www.magworld.co.uk/magweb.nsf/attachmentsbytitle/Manchester+Airport+Environment+Plan.pdf/$File/Manchester+Airport+Environment+Plan.pdf [Accessed; 01/11/2014].

MAG (2015) Traffic Statistics. Manchester Airport Group. Available On-line; http://www.manchesterairport.co.uk/about-us/publications/traffic-statistics/ [Accessed; 21/11/2014]

Manchester Airport (2007) Environment Plan. Part of the Manchester Airport Master Plan to 2030. Available On-line; http://www.magworld.co.uk/magweb.nsf/attachmentsbytitle/Manchester+Airport+Environment+Plan.pdf/$File/Manchester+Airport+Environment+Plan.pdf [Accessed; 15/09/2014].

Manchester Airport (2009) Ground Transport Plan Part of the Manchester Airport Master Plan to 2030. Available On-line; http://www.magworld.co.uk/educationpack/downloads/Grndtrans-screen-3.pdf [Accessed; 21/-5/2015].

Margretta, J. (2002), Why business models matter, *Harvard Business Online*, January, 2002.

Marks and Spencer (2015) M&S Plan A Report, 2015. Available On-line; http://planareport.marksandspencer.com/M&S_PlanAReport2015.pdf [Accessed; 21/08/2015]

Marshall, C. and Rossman, G.B. (2011) *Designing qualitative research*. 5th Edition. SAGE, London.

Martínez-Alier, J., Pascual, U., Vivien, F-D., and Zaccai, E. (2010) Sustainable de-growth: Mapping the context, criticisms and future prospects of an emergent paradigm. *Ecological Economics,* 69, 1741–1747.

Mason, K. and Miyoshi, C. (2009). Airline Business Models and their respective carbon footprint: Final Report. Omega. Available online; http://www.obsa.org/Lists/Documentacion/Attachments/271/Airline_business_models_carbon_footprint_EN.pdf [Accessed: 10/06/2013]

McManners, P. (2012) *Fly and Be Dammed*. Zed Books, London.

McNiff, J. (2001) *Action research: Principles and practice*. London, Routledge.

Meadows, D.H., Meadows, D.L., Randers, J. and Behrens, W.W. (1972) *The Limits to Growt*h. Universe Books, New York.

Meadows, D.H., Meadows, D.L., Randers, J., 1992. *Beyond the Limits: Confronting Global Collapse, Envisioning a Sustainable Future*. Chelsea Green, Post Mills, Vermont

Metcalf, A. Benn, S. (2012). Leadership for Sustainability: An Evolution of Leadership Ability. *Journal of Business Ethics*. 112, 3, 369–384.

Miles, M.B., and Huberman, A.M. (1984) *Qualitative data analysis: A sourcebook of new methods. Beverly Hills*, CA: Sage/

Miller, R. and Brewer, J. (2003) *The A-Z of Social Research: A Dictionary of Key Social Science Research Concepts*. Sage Publications, London.

Moir, L. (2001) What do we mean by corporate social responsibility. *Corporate Governance, 1, 2,* 16-22.

Monaghan, P. (2012) *Sustainability in Austerity: How local government can deliver during times of crisis*. Greenleaf Publishing, Sheffield.

Monbiot, G (2007) *Heat: How to Stop the Planet From Burning.* Penguin Books Ltd, London

Moodie (2015) Manchester Airport and World Duty Free Group unveil new Biza store. Available On-line; http://www.moodiereport.com/document.php?doc_id=44647 [Accessed; 31/10/2015]

Moody (2015) The Moodie Report Interview: ACI Europe chief Olivier Jankovec. The Moody Report. Available Online; http://www.moodiereport.com/document.php?c_id=6&doc_id=43047 [Accessed; 27/03/2015].

Moody, J.B., and Nogrady, B. (2010) *The Sixth Wave; How to succeed in a resource-limited world*. Random House, Australia.

Morgan, D.L. (1997) Planning focus groups. In D.L. Morgan and R.A. Krueger (Eds.), *The focus group kit*. Thousand Oaks, CA: Sage.

Morgan, M.G., and Henrion, M., (1990) *Uncertainty. A Guide to Dealing with Uncertainty in Quantitative Risk and Policy Analysis*. Cambridge University Press.

Morris, K (2006) Air Carrier Efficiencies. Workshop on Aviation Operational Measures for Fuel and Emissions Reductions. Available On-line; http://www.icao.int/Meetings/EnvironmentalWorkshops/Documents/ICAO-TransportCanada-2006/Morris.pdf [Accessed; 14/07/2015].

Morse, J. M. (2003) Principles of mixed methods and multimethod research design. In A. Tashakkori, & C. Teddlie (Eds.), *Handbook of mixed methods in social & behavioural research* Thousand Oaks, CA: Sage.

Natrass, B., and Altomare, M., (1999) *The Natural Step for Business. Wealth, Ecology, and The Evolutionary Corporation.* New Society Publishers, Gabriola Island, Canada.

Natural Capital Forum (2015) What is natural capital? Available On-line; http://naturalcapitalforum.com/about/ [Accessed; 27/06/2015].

Newman, A. J. (1997) *Consumption and the Inanimate Environment: The Airport Setting*. PhD Thesis. Manchester Metropolitan University.

Newman, A., Dixon, G. and Davies, B., 1994. *Towards a Study of UK Airport Retailing: The Physical Setting and Purchasing Behaviour.* Research Paper 74. Institute of Advanced Studies. Manchester Metropolitan University

Neyland, D. (2008) *Organisaztional Ethnography*. Sage Publications, London.

Nidumolu, R. Prahalad, C.K. Rangaswami, M.R. (2009) Why Sustainability Is Now the Key Driver of Innovation. *Harvard Business Review*, September 2009.

Nintendo (2015) Nintendo History. Available On-line; https://www.nintendo.co.uk/Corporate/Nintendo-History/Nintendo-History-625945.html [Accessed; 01/04/2014]

Nokia (2015) Our Story. Available On-line; http://company.nokia.com/en/about-us/our-company/our-story [Accessed; 01/04/2014]

OECD (2009) *Green Growth: Overcoming the crisis and beyond*. Paris, France. Organisation for Economic Co-operation and Development.

OECD (2011) Towards green growth: A summary for policy makers. Paris, France. Organisation for Economic Co-operation and Development. Office of Environment and Energy. January, 2005. Available on-ine; http://www.faa.gov/regulations_policies/policy_guidance/envir_policy/media/aeprimer.pdf [Accessed; 01/04/2013]

Orlikowski, W.J.,and Baroudi, J.J. (1991) Studying Information Technology in Organizations: Research Approaches and Assumptions. *Information Systems Research,* 2,1,1-28.

Ostaeyen, J.R. (2014) Analysis of the business potential of product-service systems for investment goods. Dissertation presented in partial fulfillment of the requirements or the degree of Doctor in Engineering. Arenberg Doctoral School. March, 2014. Available online; https://lirias.kuleuven.be/bitstream/123456789/429733/1/thesis.pdf [Accessed 09/04/2015].

Osterwalder, A., and Pigneur, Y. (2010). *Business Model Generation: A Handbook for Visionaries, Game Changers, and Challengers* Wiley, Chichester.

Owen, B. Lee, D. Lim, L. (2010). Flying into the Future: Aviation Emissions Scenarios to 2050. *Environmental Science and Technology*, 44, 7, 2255-2260.

Paling, C., Hooper P.D. and Thomas C.S. (2014) Sustainability of Air Transport, *Geographies of Air Transport*, Eds. Andy Goetz and Lucy Budd, Ashgate, Farnham.

Papenhausen, C (2008) Casual mechanisms of long waves. *Futures*, 40. 788-794.

Freathy, P., O'Connell, F. (1998) "The role of the buying function in airport retailing", *International Journal of Retail & Distribution Management*, 26, 6, 247 – 256.

Peeters, P. Williams, V. Hann, A. (2009). Technical and management reduction potentials. In Gossling, S. And Upham, P (eds). *Climate Change and Aviation. Issues, challenges and solutions*. London: Earthscan

Penna, C.C.R., and Geels, F.W. (2012) Multi-dimensional struggles in the greening of industry: A dialectic issue lifecycle model and case study. *Technological Forecasting & Social Change*, 79, 999-1020.

Perrini, F. and Tencati, A. (2006), Sustainability and Stakeholder Management: the Need for New Corporate Evaluation and Reporting Systems. *Business Strategy and the Environment,* 15, 296-308.

Phillips, D.C., and Burbules N.C. (2000) *Postpositivism and Educational Research.* Rowman & Littlefield Publishers, Oxford, England.

Poll, D.I.A., (2009) The optimum aeroplane and beyond, The Aeronautical Journal, Vol. 113, Number 1141, pp 151-164.

Porritt, J. (2007). *Capitalism as if the world matters*. London: Earthscan.

Porter, M.E. (1980) *Competitive Strategy. Techniques for Analyzing Industries and Competitors.* Free Press. New York

Porter, M.E. (1986) Competition in global industries: a conceptual framework, in Perter, M.E. (ed.), *Competition in Global Industries*, New York: free Press.

Porter, M.E. and Kramer, M.R. (2006) Strategy and Society: The Link Between Competitive Advantage and Corporate Social Responsibility. *Havard Business Review*. December, 2006.

PwC (2014) Two degrees of separation: ambition and reality Low Carbon Economy. Available On-line; https://www.pwc.co.uk/assets/pdf/low-carbon-economy-index-2014.pdf [Accessed; 24/07/2014].

Raibee, F., (2004) Focus-group interview and data analysis. *Proceedings of the nutrition society*, 63, 4, 655

Rappa, M. (2001). *Managing the digital enterprise - Business models on the Web*, North Carolina State University.

Ravenswood, K (2011) Eisenhardt's impact on theory in case study research, *Journal of Business Research,* 64, 7, 680-686.

Richardson, G., Ogus, A., and Burrows, P. (1982) *Policing Pollution: A Study of Regulation and Enforcement*. Clarendon Press, Oxford.

Rockström, J. (2015) Planetary Boundaries: A safe operating space for humanity. Stockholm Resilience Centre. Available Online; http://www.stockholmresilience.org/21/research/research-programmes/planetary-boundaries/planetary-boundaries-data.html [Accessed: 20/03/2015].

Rosenberg, G., Rosing, M. von, Chase, G., Omar, R., Taylor, J. and Scheel, H. von. (2011) *Applying Real-World BPM in an SAP Environment,* SAP Press, Quincy.

Rypdal, K., and Flugsrud, K. (2001) Sensitivity analysis as a tool for systematic reductions in greenhouse gas inventory uncertainties. *Environmental Science & Policy,* 4, 117–135.

Sandberg, B., and Aarikka-Stenroos, L. (2014) What makes it so difficult? A systematic review on barriers to radical innovation. *Industrial Marketing Management,* 43, 1293-1305.

Satterthwaite, D. (2009) The Implications of Population Growth and Urbanization for Climate Change. *Environment & Urbanization*, 21, 545-67.

Schaltegger, S. and Wagner, M. (2011) Sustainable Entrepreneurship and Sustainability Innovation: Categories and Interactions. *Business Strategy and the Environment,* 20, 4, 222–237.

Schaltegger, S., Lüdeke-Freund, F., & Hansen E.G. (2011) *Business Cases for Sustainability and the Role of Business Model Innovation; Developing a Conceptual Framework.* Centre for Sustainability Management (CSM).

Schmidt-Bleek, F. (2007) *Beyond Climatic change. The Factor Ten Institute*. Position Paper 08/01. 25/12/07

Schumacher, E.F. (1974) *Small is beautiful; economics as if people mattered.* Sphere Books, London.

Schumpeter, J.A. (1974). *Capitalism, Socialism and Democracy* 13th Edition. Unwin University Books: London. 1974 (First edition. 1943).

Seawright, J., Gerring, J. (2008) Case Selection Techniques in Case Study Research. *Political Research Quarterly,* 61, 2, 294-308.

Sevcik, T. (2014) The end of airport retail, the future of airport retail. *Journal of Airport Management*, Vol. 8. pp 308-311.

Sorescu, A., Frambach, R.T., Singh, J., Rangaswamy, A., and Bridges, C. (2011) Innovations in Retail Business Models, *Journal of Retailing*. 87, 1, 3-16.

Sorrell, S. (2007) *The rebound effect: An assessment of the evidence for economy-wide energy savings from improved energy efficiency*. Report by the Sussex Energy Group for the UK Energy Research Centre. London: UK Energy Research Group

Sorrell, S., Speirs, J., Bentley, R., Brandt, A., and Miller, R. (2010) Global oil depletion: A review of the evidence. *Energy Policy*, 38, 9, 5290-5295.

Steer Davies Gleave (2013) Assessment of Commercial Revenues at Heathrow Airport. Final Report. March 2014.

Stern, N. (2006) The Stern Review on the Economic Effects of Climate Change. *Population and Development Review*. 32, 4, 793–798.

Stormer, F. (2003). Making the shift: Moving from “Ethics Pays” to an inter-systems model of business. *Journal of Business Ethics*, 44, 279-289.

Stubbs, W., and Cocklin C. (2008) Conceptualizing a "Sustainability Business Model". *Organization Environment*, 21, 2 103-127.

Suchman, M. C. (1995) Managing Legitimacy: Strategic and Institutional Approaches. *Academy of Management Journal*, 20, 3, 571 - 610.

Sulzmaier, S. (2001). *Consumer-oriented business design: The case of airport management*. Heidelberg, New York: Physica-Verlag.

Sustainable Aviation (2012) Sustainable Aviation CO2 Road Map 2012. Available Online; http://www.sustainableaviation.co.uk/wp-content/uploads/SA-CO2-Road-Map-full-report-280212.pdf [Accessed 16/02/2013]

Swedavia (2013) Environmental permit with constraints for Sweden 28/11/2013. Available On-line; http://www.swedavia.com/arlanda/about-stockholm-arlanda-airport/about-stockholm-arlanda-airport/news/environmental-permit-with-constraints-for-sweden/ [Accessed; 01/09/2015]

Swilling, M. (2013) Economic crisis, long waves and the sustainability transition: An African perspective. *Environmental Innovation and Societal Transitions*, 6, 96–115.

Tainter, J.A. (2006) Archaeology of Overshoot and Collapse. *Annual Review of Anthropology*, 35, 59 -74.

Teece, D. J. (2010) Business Models, Business Strategy and Innovation. *Long Range Planning,* 43 ,172-194.

The Green Party (2015) Policy: Transport Available On-line; http://policy.greenparty.org.uk/tr.html [Accessed; 10/04/2015]

The Guardian (2012) Tesco launches UK's first virtual supermarket at Gatwick airport. Available On-line; http://www.theguardian.com/business/2012/aug/07/tesco-virtual-supermarket-gatwick-airport [Accessed; 13/08/2012]

The Tyndall Centre (2005) Decarbonising the UK; energy for a Climate Conscious Future. Available Online; http://www.tyndall.ac.uk/sites/default/files/tyndall_decarbonising_the_uk_0.pdf [Accessed 26/02/2013].

Thomas, C., Hooper, P. and Raper, D (2010) Air Transport in an Environmentally Constrained World, *Journal of Airport Management*, 5, 1, 4-6.

Thomas, C.S. with Upham, P. and Raper.D.W. (2001) Environmental capacity of aviation: theoretical issues and basic research directions. *Journal of Environmental Planning and Management.* 44, 5, 721-734.

Tiffany & Co. (2014) About Tiffany & Co. Available On-line; http://press.tiffany.com/ViewBackgrounder.aspx?backgrounderId=33 [Accessed; 01/04/2014]

Tisdell, C., Hartley, K. (2008) *Microeconomic policy: a new perspective. Edward.* Elgatt Publishing Limited, Cheltenham, UK.

Tomer, J.F. (1999) *The Human Firm: A socio-economic analysis of its behaviour and potential in a new economic age*. Routledge, London.

Tushman, M., and Anderson, P. (1986) Technological discontinuities and organization environments. *Administrative Science Quarterly,* 31, 3, 439–465.

UK Government (1997) The Economic Regulation of Airports (Expenses of the Monopolies and Mergers Commission) Regulations 1997. Available On-line; http://www.legislation.gov.uk/uksi/1997/403/body/made [Accessed; 24/05/2014].

UK Government (2008) Climate Change Act 2008. Available On-Line; http://www.legislation.gov.uk/ukpga/2008/27/contents [Accessed; 21/04/2013].

UK Government (2015a) The Airports Commission report: Carbon emissions, air quality and noise inquiry. Available On-Line; http://www.parliament.uk/business/committees/committees-a-z/commons-select/environmental-audit-committee/inquiries/parliament-2015/the-airports-commission-report-carbon-emissions-air-quality-and-noise-inquiry/ [Accessed; 21/09/2015].

UK Government (2015b) The Climate change Levy. Available On-Line; https://www.gov.uk/topic/business-tax/climate-change-levy [Accessed; 21/09/2015].

UN (2014) Big Idea 2014: The Year for Climate Action by Ban Ki-moon. Available online; http://www.un.org/climatechange/summit/2013/12/big-idea-2014-the-year-for-climate-action-by-ban-ki-moon/ [Accessed; 10/03/2015.]

UN (2015) Report of the Open Working Group on Sustainable Development Goals. United Nations. Sixty-eighth session. Agenda items 14, 19 (a) and 118. 25 August 2015. Available On-line; http://www.un.org/ga/search/view_doc.asp?symbol=A/68/970/Add.2&Lang=E [Accessed; 01/09/2015]

UNFCCC (2015) Kyoto Protocol. Available online; http://unfccc.int/kyoto_protocol/items/2830.php Accessed; 30/10/2014

Upward, A. (2013) *Towards an Ontology and Canvas for Strongly Sustainable Business Models: A Systemic Design Science Exploration*. PhD Thesis. York University,Toronto, Ontario.

Urquhart, C. and Fernandez, W. (2013), Using Grounded Theory Method: The Researcher as Blank Slate and Other Myths, *Journal of Information Technology*, 28, 224-236.

Urquhart, C. and Fernandez, W. (2013), Using Grounded Theory Method: The Researcher as Blank Slate and Other Myths, *Journal of Information Technology*, 28, 224-236.

Verdict (2014) *Global Airport Retailing 2014 Sales growth through airports cleared for take-off*. Verdict, February 2014.

Viscotchi, F. (2006) Aviation Operational Measures for Fuel and Emissions Reduction Workshop; eight Management. ICAO. Available On-line; http://www.icao.int/Meetings/EnvironmentalWorkshops/Documents/ICAO-TransportCanada-2006/Viscotchi.pdf[Accessed; 14/07/2015].

Volkova, N. (2011) Determinants of retail revenue for today’s airports. Berlin School of Economics. Available On-line; http://userpage.fu-berlin.de/~jmueller/gapprojekt/downloads/gap_papers/The%20role%20of%20retail%20revenue%20for%20today's%20airports_Bremen%20rev%20jm%2011%207%2009.pdf [Accessed; 30/09/2014]

Wagner, O. (2008) *Shopping Paradise Airport*. VDM Publishing. Saarbrücken.

Wall Street Journal (2015) Threats to Global Financial Stability Are Rising, the IMF Says Available On-Line; http://blogs.wsj.com/economics/2015/04/15/threats-to-global-financial-stability-are-worsening-the-imf-says/ [Accessed; 20/05/2015].

Wallmann, S.M.H. (1995) The future of accounting and disclosure in an evolving world: the need for dramatic change. *Accounting Horizons*, 9, 3, 81–91.

Walsh, I (2014) Using quantitative data in mixed-design grounded theory studies: an enhanced path to formal grounded theory in information systems. *European Journal of Information Systems, 6,* 1-27

Walsham, G. (1995). Interpretive case studies in information systems research: Nature and method. *European Journal of Information Systems*, 4, 74-81.

WDFG (2013) *Suppliers Policy*. Version 2. 4 March 2013. Wolrd Duty Free Group.

WDFG (2014a) Sustainability Report 2014. World Duty Free Group. Available On-line; http://www.worlddutyfreegroup.com/wp-content/uploads/2015/05/2014-WDFG-SPA_Sustainability-Report.pdf [Accessed; 21/06/2015]

WDFG (2014b) Global Travel Retail Excellence. World Duty Free Group. Available On-line; http://www.worlddutyfreegroup.com/wp-content/uploads/2013/10/brochure_wdfg_en.pdf [Accessed; 21/06/2015]

WDFG (2014c) One Water Foundation Press Release. World Duty Free Group, Available On-line; http://www.worlddutyfreegroup.com/wp-content/uploads/2014/05/060514-WDFG-One-Foundation-release.pdf [Accessed; 18/09/2014]

Weill, P., Malone, T.W., D'Urso,, V.T., Herman, G., and Woerner, S. (2005) Do Some Business Models Perform Better than Others? A Study of the 1000 Largest US Firms. *Sloan School of Management*. Massachusetts Institute of Technology.

Weizsäcker, E.V., Lovins, A.B., and Lovins, L.H., (1997). *Factor four: doubling wealth–halving resource use.* Earthscan, London, 320 pp.

Wells, P.E. (2013) *Business Models for Sustainability.* Edward Elgar Publishing Limited, Cheltenham.

Wire, T. (2009) *Fewer Emitters, Lower Emissions, Less Costs: Reducing Future Carbon Emissions by investing in family planning, A Cost-Benefit Analysis*. London School of Economics, London.

Wirtz, B.W., Pistoia, A., Ullrich, S., and Göttel., V. (2015) Business Models: Origin, Development and Future Research Perspectives, *Long Range Planning*. Article in Press.

World Bank (2011) Data; United Kingdom. Available On-line; http://data.worldbank.org/country/united-kingdom [Accessed; 21/10/2015].

World Bank (2013) Remarkable Declines in Global Poverty, But Major Challenges Remain. Available Online; https://www.worldbank.org/en/news/press-release/2013/04/17/remarkable-declines-in-global-poverty-but-major-challenges-remain [Accessed; 06/03/2015]

WBSCD (2010) *Vision 2050: The new agenda for business.* World Business Council for Sustainable Development (WBCSD), Geneva (2010).

WRI (2004) The Greenhouse Gas Protocol. A Corporate Accounting and Reporting Standard. Revised Edition. World Resources Initiative. Available Online: http://www.ghgprotocol.org/files/ghgp/public/ghg-protocol-revised.pdf [Accessed; 10/01/2014].

Wright, L. A., S. Kemp, and Williams, I. (2011). 'Carbon Footprinting': towards a universally accepted definition. *Carbon Management* 2,1, 61-72.

WWF (2012) Living Planet Report 2015. World Wildlife Fund. Biodiversity, bio-capacity and better choices. Available On-line; http://d2ouvy59p0dg6k.cloudfront.net/downloads/1_lpr_2012_online_full_size_single_pages_final_120516.pdf [Accessed; 01/09/2015]

Yi-Hsin Lin, Y-H., Chen, C-F. (2013) Passengers' shopping motivations and commercial activities at airports – The moderating effects of time pressure and impulse buying tendency, *Tourism Management*, 36, 426-434.

Yin, R. K. (1994). *Case study research: Design and methods* Sage Publications.

Yin, R. K. (2011) *Qualitative Research from Start to Finish*. The Guilford Press, New York.

Yin, R. K., ed., (2003), *The Case Study Anthology.* Thousand Oaks, CA: Sage Publication Inc.

Yunus, M., Moingeon, B. and Lehmann-Ortega, L. (2010) Building Social Business Models: Lessons from the Grameen Experience. *Long Range Planning*, 43, 308 325

Zott, C., Amit, R. and Massa, L. (2011) The business model: recent developments and future research, *Journal of Management*, 37, 4, 1019–1042.

10. Appendices

Appendix A; Materiality Testing of Water emissions calculations data

Sensitivity Analysis	Manchester T1 (KwH)	Manchester T2 (KwH)	Manchester T3 (KwH)	Direct Carbon Emissions	WTT Carbon emissions (tCO_2e)	Total Carbon Emissions (tCO_2e)	Emissions change (tCO_2e)
kWh +10%	1426993.93	874910.82	229199.45	1240823.218	174342.4582	1415.165677	128.651
kWh +5%	1362130.57	835142.15	218781.29	1184422.163	166417.801	1350.839964	64.326
Actual	1297267.2	795373.48	208363.14	1128021.108	158493.1438	1286.514251	0.000
kWh -10%	1232403.85	755604.80	197944.98	1071620.052	150568.4866	1222.188539	-64.326
kWh -10%	1167540.48	715836.13	187526.82	1015218.997	142643.8294	1157.862826	-128.651

Appendix B; Waste emissions calculations data

Total WDFG Recycled Waste													
Waste Type	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Total**
Cardboard (tonnes)	84.48	53.04	73.54	88.46	64.26	81.84	108.22	111.28	102.22	86.08	88.96	102.8	1045.18
Plastic (tonnes)	1	1.44	1.98	1.18	3.12	3.36	3.64	2.18	4.86	2.08	3.08	1.82	29.74
Printer Cartridges (tonnes)	0	0	0	0	0	0	1	0	0	0	0	0	1
Wood (tonnes)	0	0	0	0	0	0	0	0	0	0	0	0	0
Metal (tonnes)	0	0	0	1.54	0	0	0	0	3.82	0	3.14	1.68	10.18
Electrical (tonnes)	0	0	0	0	0	0	0	0	0	0	0	0	0
Waste to recycling (tonnes)	13.72	14.62	14.48	6.12	22	13.94	15.74	14.7	17.1	13.28	13.42	5.6	164.72
Waste to energy (tonnes)	2.9	3.62	2.08	4.64	5.1	2.26	4.32	2.3	5.12	5.62	4.52	5.18	47.66
Total Recycling (tonnes)	102.1	72.72	92.08	101.94	94.48	101.4	132.92	130.46	133.12	107.06	113.12	117.08	1298.48
Waste to Landfill (tonnes)	0	0	0	0	0	0	0	0	0	0	0	0	0

Calculating the proportion of WDFG waste attributable to Manchester Airport		
Airport	Passengers	Percentage
Aberdeen	3,723,411.00	1.64
Belfast	4,031,685.00	1.77
Birmingham	9,698,488.00	4.26
Bouremouth	660,374.00	0.29
Bristol	6,333,058.00	2.78
East Midlands	4,506,791.00	1.98
Edinburgh	10,158,906.00	4.47
Exeter	766,572.00	0.34
Gatwick	38,093,930.00	16.75
Glasgow	7,708,867.00	3.39
Heathrow	73,371,096.00	32.26
Humerside	237,329.00	0.10
Jersey	1,474,615	0.65
Leeds	3,263,247.00	1.43
Liverpool	3,984,023.00	1.75
Manchester	***21,950,223.00***	***9.65***
Luton	10,481,501.00	4.61
Newcastle	4,512,976.00	1.98
Robin Hood	724,252.00	0.32
Southampton	1,829,575.00	0.80
Stanstead	19,958,047.00	8.77

Manchester Waste				
Total Volume WDFG Waste produced at UK Airports (tonnes)	**Manchester Airport WDFG Waste (tonnes)[110]**	**DEFRA Conversion Factor for recycled waste ($kgCO_2e$/tonne)**	**Total (tCO_2e)**	**Total Volume WDFG Waste produced at UK Airports (tonnes)**
Cardboard (tonnes)	1045.18	100.86	21.00	2.12
Plastic (tonnes)	29.74	2.87	21.00	0.06
Printer Cartridges (tonnes)	1	0.10	21.00	0.00
Wood (tonnes)	0	0.00	21.00	0.00
Metal (tonnes)	10.18	0.98	21.00	0.02
Electrical (tonnes)	0	0.00	21.00	0.00
Waste to energy (tonnes)	47.66	4.60	21.00	0.10
				2.3

110 Assumes waste is proportional to passenger numbers. Manchester is responsible for 9.65% of passengers where WDFG operate in the UK.

Appendix C; Materiality Testing of waste emissions calculations

Waste				Carbon			
Manchester Contributing 5% of Total WDFG Waste (tonnes)	Manchester Contributing 10% of Total WDFG Waste (tonnes)	Manchester Contributing 15% of Total WDFG Waste (tonnes)	Manchester Contributing 25% of Total WDFG Waste (tonnes)	Manchester Contributing 5% of Total WDFG Waste (tCO2e)	Manchester Contributing 10% of Total WDFG Waste (tCO2e)	Manchester Contributing 15% of Total WDFG Waste (tCO2e)	Manchester Contributing 25% of Total WDFG Waste (tCO2e)
52.259	104.518	156.777	209.036	1.097439	2.194878	3.292317	4.389756
1.487	2.974	4.461	0.5948	0.031227	0.062454	0.093681	0.0124908
0.05	0.1	0.15	0.02	0.00105	0.0021	0.00315	0.00042
0	0	0	0	0	0	0	0
0.509	1.018	1.527	0.2036	0.010689	0.021378	0.032067	0.0042756
0	0	0	0	0	0	0	0
8.236	16.472	24.708	3.2944	0.172956	0.345912	0.518868	0.0691824
2.383	4.766	7.149	0.9532	0.050043	0.100086	0.150129	0.0200172
0	0	0	0	0	0	0	0
64.924	129.848	194.772	214.102	1.363404	2.726808	4.090212	4.496142
			Difference in calculations figures (tCO_2e)	-1.27	0.10	1.46	1.86

Appendix D; Materiality testing of distribution emissions calculations

Deliveries to the Airport	Average round trip distance per delivery (miles)	Total Annual Distance (miles)	Truck emissions per (kgCO2e/mile)	Total Emissions per year in deliveries to the airport (tCO_2e)	Well to tank Carbon Conversion (per mile) (kgCO2e/mile)	Total Well to Tank Carbon (tCO_2e)	Total Delivery Carbon (tCO_2e)	Difference (tCO_2e)
Original Data	400	146000	1.681831962	245.55	0.367201975	53.61	299.16	0
Distance Change								
-25	375	136875	1.681831962	230.20	0.367201975	50.26	280.46	-18.70
-10	390	142350	1.681831962	239.41	0.367201975	52.27	291.68	-7.48
-5	395	144175	1.681831962	242.48	0.367201975	52.94	295.42	-3.74
5	405	147825	1.681831962	248.62	0.367201975	54.28	302.90	3.74
10	410	149650	1.681831962	251.69	0.367201975	54.95	306.64	7.48
25	425	155125	1.681831962	260.89	0.367201975	56.96	317.86	18.70
Conversion Factor Change								Difference
Rigid (>3.5 - 7.5 tonnes)	400	146000	0.98964904	144.49	0.216074548	31.55	176.04	-123.12
Rigid (>7.5 tonnes-17 tonnes)	400	146000	1.286127908	187.77	0.28080612	41.00	228.77	-70.39
Rigid (>17 tonnes)	400	146000	1.822942509	266.15	0.398011278	58.11	324.26	25.10
All rigids	400	146000	1.535684325	224.21	0.3352929	48.95	273.16	-26.00
Articulated (>3.5 - 33t)	400	146000	1.648863092	240.73	0.360003732	52.56	293.29	-5.86
Articulated (>33t)	400	146000	1.846872951	269.64	0.40323612	58.87	328.52	29.36
All articulated	400	146000	1.807132378	263.84	0.394559381	57.61	321.45	22.29

Appendix E; Materiality Testing of business travel emissions calculations data

Site employees travelling on business		6 (increase of 1)			
Average number of trips per year		50 (increase of 20)			
Average distance travelled		100			
Total Distance Travelled (miles)		30000			
Type of Travel	**Percentage**	**Annual Distance Travelled (miles)**	**DEFRA Conversion Factor (tCO_2e/mile)**	**Emissions (tCO_2e)**	**Change (tCO_2e)**
car	35%	10500	0.293415598	3.08	1.54
foot	5%	1500	0	0.00	0.00
flight	25%	7500	0.29795	2.23	1.12
bus	10%	3000	0.10033	0.48	0.24
train	20%	6000	0.045057182	0.44	0.22
bicycle	5%	1500	0	0.00	0.00
				6.234958074	**3.12**

Appendix F; WDFG employee travel data

Location	Postal Code	Car parking?	Work Pattern	Mode	Days Per Week	Daily Commute Distance (miles)	Annual Distance Travelled (miles)
T1	ST7 2PG	YES	1 of 7	Car	1	29.4	3057.6
T2	M23 0PA	YES	1 of 7	Car	1	4.7	488.8
T3	OL7 0DH	YES	1 of 7	Car	1	15.2	1580.8
T3	M33 5RA	YES	2 of 7	Car	2	11.2	2329.6
T1	SK14 4UU	YES	2 of 7	Car	2	16.9	3515.2
T2	M23 2XE	YES	2 of 7	Car	2	3.2	665.6
T3	M19 1EJ	YES	2 of 7	Car	2	8.6	1788.8
T1	WA5 1JT	YES	2 of 7	Car	2	24.9	5179.2
T3	WA15 7HT	YES	2 of 7	Car	2	4.6	956.8
T2	SK4 2AL	YES	3 & 3	Car	3	8.7	2714.4
T2	SK8 1BW	YES	3 & 3	Car	3	7.5	2340
T3	M24 2PL	YES	3 & 3	Car	3	21.6	6739.2
T1	M40 1NX	YES	3 & 3	Car	3	21	6552
T1	SK7 6NE	YES	3 & 3	Car	3	10.7	3338.4
T1	M22 5NG	YES	3 & 3	Car	3	1.9	592.8
T1	M22 4BY	YES	3 & 3	Car	3	4.7	1466.4
T2	ST1 2DQ	YES	3 & 3	Car	3	39.5	12324
T3	WA3 6FA	YES	3 & 3	Car	3	17.6	5491.2
T2	M33 2RB	YES	3 & 3	Car	3	5.6	1747.2
T1	M8 0SG	YES	3 & 3	Car	3	12.4	3868.8
T2	OL9 7HR	YES	3 & 3	Car	3	18.5	5772
T2	M18 8UG	YES	3 & 3	Car	3	14.2	4430.4
T2	M24 1HE	YES	3 & 3	Car	3	20.7	6458.4
T1	WA11 0EL	YES	3 & 3	Car	3	25.4	7924.8
T3	NG2 1DW	YES	3 & 3	Car	3	92.2	28766.4
T2	SK5 8AY	YES	3 & 3	Car	3	10.2	3182.4
T1	M9 8QD	YES	3 & 3	Car	3	23.8	7425.6
T1	M31 4AW	YES	3 & 3	Car	3	11.7	3650.4
T2	M31 4AW	YES	3 & 3	Car	3	11.7	3650.4
T2	M23 2QQ	YES	3 & 3	Car	3	3.4	1060.8
T1	WA3 6JQ	YES	3 & 3	Car	3	18.4	5740.8
T1	M31 4WA	YES	3 & 3	Car	3	13.3	4149.6
T1	PR8 6NG	YES	3 & 3	Car	3	44.7	13946.4
T1	SK8 4ET	YES	3 & 3	Car	3	3.7	1154.4
T2	M14 7LN	YES	3 & 3	Car	3	7.8	2433.6
T2	M20 6TX	YES	3 & 3	Car	3	7	2184
T2	WA15 6DA	YES	3 & 3	Car	3	5.6	1747.2
T1	CW2 5JY	YES	3 & 3	Car	3	34.6	10795.2
T3	WA15 8QB	YES	3 & 3	Car	3	3.9	1216.8
T1	WA3 5LQ	YES	3 & 3	Car	3	23.3	7269.6
T1	M14 7HY	YES	3 & 3	Car	3	8	2496
T1	CW10 9ER	YES	3 & 3	Car	3	22.7	7082.4
T1	WA15 8QB	YES	3 of 7	Car	3	3.9	1216.8

T3	LS12 5UA	YES	3 of 7	Car	3	50.6	15787.2
T3	BL8 2HU	YES	3 of 7	Car	3	25.4	7924.8
T2	SK8 3TP	YES	3 of 7	Car	3	2.5	780
T1	SK7 2BT	YES	3 of 7	Car	3	6.9	2152.8
T3	M22 4WH	YES	3 of 7	Car	3	5	1560
T1	SK14 1JP	YES	3 of 7	Car	3	15.5	4836
T2	SK16 4XB	YES	3 of 7	Car	3	16.5	5148
T2	M22 9YN	YES	3 of 7	Car	3	2.5	780
T1	M22 5AR	YES	3 of 7	Car	3	2.2	686.4
T2	WN3 4TT	YES	3 of 7	Car	3	28.5	8892
T2	M23 2UP	YES	3 of 7	Car	3	3.9	1216.8
T2	BL9 8HG	YES	3 of 7	Car	3	21.1	6583.2
T1	M16 8NW	YES	3 of 7	Car	3	7.5	2340
T1	BL4 7HH	YES	3 of 7	Car	3	20.8	6489.6
T2	OL11 5JN	YES	3 of 7	Car	3	29.3	9141.6
T1	CW12 1LY	YES	3 of 7	Car	3	16.7	5210.4
T1	CW8 4NW	YES	3 of 7	Car	3	21.5	6708
T1	SK8 6BH	YES	3 of 7	Car	3	3.3	1029.6
T3	M14 7FT	YES	4 of 7	Car	4	7.9	3286.4
T2	M33 2TR	YES	4 of 7	Car	4	6.6	2745.6
T1	WA5 8DX	YES	4 of 7	Car	4	24	9984
T3	SK3 0UR	YES	4 of 7	Car	4	7.7	3203.2
T2	WA11 0EP	YES	4 of 7	Car	4	25.3	10524.8
T2	SK5 6PT	YES	4 of 7	Car	4	14	5824
T1	WN3 5RG	YES	4 of 7	Car	4	27.1	11273.6
T2	M23 0DX	YES	4 of 7	Car	4	5.2	2163.2
T2	M22 9WT	YES	4 of 7	Car	4	2.7	1123.2
T1	WA3 6TH	YES	4 of 7	Car	4	21.3	8860.8
T1	SK8 3SX	YES	4 of 7	Car	4	2.9	1206.4
T3	OL6 8SQ	YES	4 of 7	Car	4	17.3	7196.8
T3	SK6 2DX	YES	4 of 7	Car	4	11.2	4659.2
T1	M22 5TF	YES	4 of 7	Car	4	1.8	748.8
T2	WN2 1QR	YES	4 of 7	Car	4	26.6	11065.6
T1	BB1 3JN	YES	4 of 7	Car	4	47	19552
T1	M23 1LQ	YES	4 of 7	Car	4	5.1	2121.6
T2	M19 1QT	YES	4 of 7	Car	4	8.1	3369.6
T2	M7 1AJ	YES	4 of 7	Car	4	11.8	4908.8
T3	SK8 2EY	YES	4 of 7	Car	4	7.3	3036.8
T2	WA3 6FA	YES	4 of 7	Car	4	17.6	7321.6
T1	M22 4EF	YES	4 of 7	Car	4	5.1	2121.6
T1	BL5 2RH	YES	4 of 7	Car	4	25	10400
T1	CW10 9GS	YES	4 of 7	Car	4	22.7	9443.2
T1	SK8 1NQ	YES	4 of 7	Car	4	4.2	1747.2
T2	SK4 3DA	YES	4 of 7	Car	4	7.6	3161.6
T1	M22 8UB	YES	4 of 7	Car	4	2.9	1206.4
T2	M23 1BL	YES	4 of 7	Car	4	4.9	2038.4
T1	M22 1AU	YES	4 of 7	Car	4	2.4	998.4

T1	M28 1HZ	YES	4 of 7	Car	4	16	6656
T3	HD7 4NB	YES	4 of 7	Car	4	39.2	16307.2
T1	M16 0BD	YES	4 of 7	Car	4	8.2	3411.2
T1	M13 0UE	YES	4 of 7	Car	4	9.6	3993.6
T1	SK13 1NR	YES	4 of 7	Car	4	19.9	8278.4
T3	M19 2LW	YES	4 of 7	Car	4	8.7	3619.2
T2	M9 4PN	YES	4 of 7	Car	4	21	8736
T3	M22 5FS	YES	4 of 7	Car	4	2.1	873.6
T3	M25 0AT	YES	4 of 7	Car	4	24	9984
T2	SK1 2JX	YES	4 of 7	Car	4	9.4	3910.4
T1	SK8 5PD	YES	4 of 7	Car	4	4.5	1872
T2	SK23 7BQ	YES	4 of 7	Car	4	16.4	6822.4
T2	SK1 4JX	YES	4 of 7	Car	4	10.7	4451.2
T2	BL1 4TS	YES	4 of 7	Car	4	22.4	9318.4
T1	RH10 7RX	YES	4 of 7	Car	4	230.8	96012.8
T1	SK10 3QD	YES	4 of 7	Car	4	13.3	5532.8
T2	OL7 9DR	YES	4 of 7	Car	4	16.4	6822.4
T2	M33 4RP	YES	4 of 7	Car	4	10	4160
T2	M22 5ES	YES	4 of 7	Car	4	2	832
T1	WA13 0LQ	YES	4 of 7	Car	4	11.5	4784
T1	M34 7RD	YES	4 of 7	Car	4	13.1	5449.6
T2	M22 9TW	YES	4 of 7	Car	4	2.8	1164.8
T1	M27 5NJ	YES	4 of 7	Car	4	16.7	6947.2
T1	FY5 3QA	YES	4 of 7	Car	4	59	24544
T1	BB4 7PA	YES	5 of 7	Car	5	35.5	18460
T3	M20 2XW	YES	5 of 7	Car	5	5.7	2964
T2	SK8 RR	YES	5 of 7	Car	5	3.6	1872
T1	WA14 2EL	YES	5 of 7	Car	5	5.5	2860
T1	BL2 1NE	YES	5 of 7	Car	5	21.5	11180
T3	WN5 7TN	YES	5 of 7	Car	5	28.4	14768
T2	M50 3AX	YES	5 of 7	Car	5	11.3	5876
T1	WF9 1HP	YES	5 of 7	Car	5	73.5	38220
T1	OL8 1AH	YES	5 of 7	Car	5	19	9880
T1	SK3 8JS	YES	5 of 7	Car	5	9.1	4732
T2	L35 4LT	YES	5 of 7	Car	5	27.3	14196
T1	M22 5JS	YES	5 of 7	Car	5	1.7	884
T1	M33 2EG	YES	5 of 7	Car	5	7.7	4004
T3	M41 0XY	YES	5 of 7	Car	5	10.9	5668
T2	M26 3GL	YES	5 of 7	Car	5	23	11960
T1	SK15 3HP	YES	5 of 7	Car	5	18.5	9620
T3	PR1 9LA	YES	5 of 7	Car	5	40.3	20956
T2	CW9 7PE	YES	5 of 7	Car	5	15.8	8216
T1	SK2 5QJ	YES	5 of 7	Car	5	10.9	5668
T2	BB4 6AW	YES	5 of 7	Car	5	35	18200
T3	SK8 1QY	YES	5 of 7	Car	5	4.5	2340
T2	M28 0HU	YES	5 of 7	Car	5	16.6	8632
T3	SK7 1LG	YES	5 of 7	Car	5	7	3640

T1	M9 7GH	YES	5 of 7	Car	5	19.7	10244
T1	M34 3HL	YES	5 of 7	Car	5	13.7	7124
T2	M4 4AP	YES	5 of 7	Car	5	11.8	6136
T1	OL5 0HJ	YES	5 of 7	Car	5	19.1	9932
T3	SK14 8HY	YES	5 of 7	Car	5	19	9880
T1	SK7 3HA	YES	5 of 7	Car	5	6.3	3276
T1	M41 6QQ	YES	5 of 7	Car	5	12.5	6500
T2	BL5 1ES	YES	5 of 7	Car	5	21.2	11024
T1	M33 4LF	YES	5 of 7	Car	5	7.1	3692
T2	M16 9GQ	YES	5 of 7	Car	5	8.5	4420
T1	M15 4JP	YES	5 of 7	Car	5	11.4	5928
T2	M23 1PL	YES	5 of 7	Car	5	5.1	2652
T2	M33 4LP	YES	5 of 7	Car	5	7.4	3848
T1	M1 6BE	YES	5 of 7	Car	5	10	5200
T1	M40 9QE	YES	5 of 7	Car	5	20.6	10712
T3	WA5 3TF	YES	5 of 7	Car	5	24.7	12844
T3	WN6 7NQ	YES	5 of 7	Car	5	30.1	15652
T2	M14 6FJ	YES	5 of 7	Car	5	8	4160
T1	M22 5LF	YES	5 of 7	Car	5	1.8	936
T1	SK4 4QQ	YES	5 of 7	Car	5	9.7	5044
T1	M16 7QX	YES	5 of 7	Car	5	8.7	4524
T2	OL7 0AL	YES	5 of 7	Car	5	15.6	8112
T2	BL4 0PQ	YES	5 of 7	Car	5	21	10920
T1	WA15 7JN	YES	5 of 7	Car	5	4.7	2444
T1	SK2 6LD	YES	5 of 7	Car	5	10.1	5252
T2	WA12 9PU	YES	5 of 7	Car	5	24.7	12844
T1	M33 2NY	YES	5 of 7	Car	5	8.4	4368
T1	M32 9QA	YES	5 of 7	Car	5	10.8	5616
T2	M8 4JU	YES	5 of 7	Car	5	23.6	12272
T1	OL10 3BQ	YES	5 of 7	Car	5	27.6	14352
T1	SK73PT	YES	5 of 7	Car	5	6.7	3484
T1	M33 3PS	YES	5 of 7	Car	5	6.1	3172
T1	SK8 5QR	YES	5 of 7	Car	5	8.5	4420
T1	M31 4RD	YES	5 of 7	Car	5	13.3	6916
T1	M33 5FA	YES	5 of 7	Car	5	11.4	5928
T2	SK4 4PE	YES	5 of 7	Car	5	9.8	5096
T3	WA15 8TJ	YES	5 of 7	Car	5	4.1	2132
T1	CW10 0BA	YES	5 of 7	Car	5	23.1	12012
T2	SK3 0PP	YES	5 of 7	Car	5	6.9	3588
T1	SK4 2HT	YES	5 of 7	Car	5	8.5	4420
T1	SK8 2JW	YES	5 of 7	Car	5	7.7	4004
T1	CW8 4BN	YES	5 of 7	Car	5	22.8	11856
T3	M6 5ND	YES	5 of 7	Car	5	14.5	7540
T2	SK2 7PS	YES	5 of 7	Car	5	11.6	6032
T1	BL3 3DR	YES	5 of 7	Car	5	21.2	11024
T3	SK15 3GN	YES	5 of 7	Car	5	18.5	9620
T2	SK8 3BT	YES	5 of 7	Car	5	3.2	1664

T1	SK6 2NU	YES	5 of 7	Car	5	11.5	5980
T2	M20 4RQ	YES	5 of 7	Car	5	8.2	4264
T2	M25 9UN	YES	5 of 7	Car	5	20.7	10764
T1	SK8 6PZ	YES	5 of 7	Car	5	4.3	2236
T2	M14 7AH	YES	5 of 7	Car	5	7.8	4056
T2	M23 2ZF	YES	5 of 7	Car	5	3.4	1768
T2	WA37HJ	YES	5 of 7	Car	5	19.8	10296
T3	WA3 7HJ	YES	5 of 7	Car	5	19.8	10296
T2	WA3 1EY	YES	5 of 7	Car	5	23.2	12064
T2	M23 0DZ	YES	5 of 7	Car	5	5.2	2704
T2	SK6 6AL	YES	5 of 7	Car	5	13.5	7020
T2	SK15 3RW	YES	5 of 7	Car	5	19.2	9984
T3	WA11 0PS	YES	5 of 7	Car	5	24.1	12532
T2	WA5 2SX	YES	5 of 7	Car	5	25.1	13052
T2	SK9 2NL	YES	5 of 7	Car	5	4.7	2444
T1	BL3 3QY	YES	5 of 7	Car	5	21.1	10972
T1	SK3 9JT	YES	5 of 7	Car	5	8.9	4628
T1	M31 4QA	YES	5 of 7	Car	5	14	7280
T1	SK2 7LJ	YES	5 of 7	Car	5	11.4	5928
T1	SK8 3AR	YES	5 of 7	Car	5	3.2	1664
T1	M29 8NR	YES	5 of 7	Car	5	17.2	8944
T3	M31 4DU	YES	5 of 7	Car	5	12.3	6396
T3	M6 7PR	YES	5 of 7	Car	5	16.3	8476
T2	WN6 7RQ	YES	M - F	Car	5	30.1	15652
T2	M19 2JJ	YES	Weekends only	Car	2	8.9	1851.2
T1	M8 0LS	YES	Weekends only	Car	2	12.4	2579.2
T1	OL6 7EJ	YES	Weekends only	Car	2	15.8	3286.4
T1	BL3 6QG	YES	Weekends only	Car	2	20.9	4347.2
T1	SK8 6BY	YES	Weekends only	Car	2	3.4	707.2
T2	SK8 6HA	YES	Weekends only	Car	2	3.9	811.2
T2	OL6 8UY	YES	Weekends only	Car	2	17.9	3723.2
T1	M22 1GZ	YES	Weekends only	Car	2	1.9	395.2
T1	OL9 0NF	YES	Weekends only	Car	2	20.6	4284.8
T1	SK3 8UB	YES	Weekends only	Car	2	9.9	2059.2
T1	M20 5WA	YES	Weekends only	Car	2	6.9	1435.2
T2	M40 0BA	YES	Weekends only	Car	2	20.2	4201.6
T1	M19 2HP	YES	Weekends only	Car	2	9.6	1996.8
T2	BB3 0TD	YES	Weekends only	Car	2	42.9	8923.2
T2	M23 1FG		1 of 7	Public Trnspt	1	4.1	426.4
T2	WN4 9UZ		1 of 7	Public Trnspt	1	36.6	3806.4
T2	M22 8JU		1 of 7	Public Trnspt	1	3.2	332.8
T3	M19 3NQ		2 of 7	Public Trnspt	2	13.9	2891.2
T2	M22 0EH		2 of 7	Public Trnspt	2	1.5	312
T1	M22 1QY		2 of 7	Public Trnspt	2	2.8	582.4

T1	M20 4TG		3 & 3	Public Trnspt	3	6.5	2028
T2	SK8 7BG		3 & 3	Public Trnspt	3	6.2	1934.4
T1	M23 1WA		3 & 3	Public Trnspt	3	3.3	1029.6
T3	M22 8DH		3 & 3	Public Trnspt	3	3.4	1060.8
T1	M23 0LJ		3 & 3	Public Trnspt	3	6.2	1934.4
T3	M5 3LP		3 & 3	Public Trnspt	3	13	4056
T1	SK6 2HX		3 & 3	Public Trnspt	3	9.9	3088.8
T1	M18 7JG		3 & 3	Public Trnspt	3	14.3	4461.6
T3	HR6 8UP		3 & 3	Public Trnspt	3	95.3	29733.6
T2	M19 1QT		3 & 3	Public Trnspt	3	6.5	2028
T2	M19 1AP		3 & 3	Public Trnspt	3	6.9	2152.8
T3	SK3 9NT		3 & 3	Public Trnspt	3	7.7	2402.4
T1	BL1 8TL		3 & 3	Public Trnspt	3	24.8	7737.6
T3	M19 1LP		3 & 3	Public Trnspt	3	6.5	2028
T2	M9 8EA		3 & 3	Public Trnspt	3	14.3	4461.6
T3	SK9 2HE		3 & 3	Public Trnspt	3	9.7	3026.4
T2	M33 2XF		3 & 3	Public Trnspt	3	7.1	2215.2
T1	M22 4QJ		3 & 3	Public Trnspt	3	3.8	1185.6
T2	M22 4QS		3 & 3	Public Trnspt	3	3.3	1029.6
T1	M22 9YA		3 & 3	Public Trnspt	3	2.8	873.6
T2	M22 5EN		3 & 3	Public Trnspt	3	2.5	780
T1	M22 1NN		3 & 3	Public Trnspt	3	1	312
T2	WA14 5BD		3 & 3	Public Trnspt	3	7.3	2277.6
T2	M21 9ED		3 of 7	Public Trnspt	3	9.5	2964
T1	M16 0LB		3 of 7	Public Trnspt	3	14.3	4461.6
T2	M22 1UU		3 of 7	Public Trnspt	3	2.9	904.8
T1	M32 0ZP		3 of 7	Public Trnspt	3	14.4	4492.8
T2	BL3 2LX		3 of 7	Public Trnspt	3	23.3	7269.6
T1	M22 9JF		3 of 7	Public Trnspt	3	2.5	780
T1	SK7 3EZ		3 of 7	Public Trnspt	3	7.4	2308.8
T3	M13 0TH		3 of 7	Public Trnspt	3	14.3	4461.6
T1	M7 2JZ		4 of 7	Public Trnspt	4	13.9	5782.4
T3	M22 8FG		4 of 7	Public Trnspt	4	4.8	1996.8
T1	M15 4EG		4 of 7	Public Trnspt	4	12	4992
T1	M1 3GB		4 of 7	Public Trnspt	4	10.8	4492.8
T1	WA14 2QT		4 of 7	Public Trnspt	4	5.6	2329.6
T1	M23 0WQ		4 of 7	Public Trnspt	4	5.9	2454.4
T1	M32 8GL		4 of 7	Public Trnspt	4	15.5	6448
T3	M22 1PP		4 of 7	Public Trnspt	4	1	416
T1	M22 4JU		4 of 7	Public Trnspt	4	3.9	1622.4
T2	M41 0ZA		4 of 7	Public Trnspt	4	12.3	5116.8
T3	M22 4GP		4 of 7	Public Trnspt	4	3	1248
T1	M22 1TU		4 of 7	Public Trnspt	4	1.4	582.4
T3	WA14 2DD		4 of 7	Public Trnspt	4	5.4	2246.4
T1	BL4 9HQ		4 of 7	Public Trnspt	4	25.1	10441.6
T1	M13 0FJ		4 of 7	Public Trnspt	4	12.5	5200
T2	M14 6EJ		4 of 7	Public Trnspt	4	7.9	3286.4

T3	M1 3BB		4 of 7	Public Trnspt	4	11	4576
T1	M22 9PU		4 of 7	Public Trnspt	4	2.4	998.4
T1	SK8 3QJ		4 of 7	Public Trnspt	4	2.4	998.4
T2	M23 0EX		4 of 7	Public Trnspt	4	6.5	2704
T1	WA3 2BN		4 of 7	Public Trnspt	4	29.6	12313.6
T2	M33 2ZL		4 of 7	Public Trnspt	4	6.5	2704
T1	WN7 5JQ		4 of 7	Public Trnspt	4	38.3	15932.8
T1	M23 2UY		4 of 7	Public Trnspt	4	3.3	1372.8
T1	M13 0BU		4 of 7	Public Trnspt	4	12.5	5200
T1	WN6 7LU		4 of 7	Public Trnspt	4	33.5	13936
T2	SK14 4PT		5 of 7	Public Trnspt	5	17.8	9256
T3	M41 9PL		5 of 7	Public Trnspt	5	11.1	5772
T1	SK3 9QH		5 of 7	Public Trnspt	5	8	4160
T2	M22 1EQ		5 of 7	Public Trnspt	5	1.2	624
T1	M27 5QY		5 of 7	Public Trnspt	5	16.5	8580
T2	SK22 3HN		5 of 7	Public Trnspt	5	14.2	7384
T3	M23 2XZ		5 of 7	Public Trnspt	5	3.2	1664
T1	M20 4ZB		5 of 7	Public Trnspt	5	5.8	3016
T2	M41 0ZA		5 of 7	Public Trnspt	5	12.3	6396
T2	M20 2YJ		5 of 7	Public Trnspt	5	5.3	2756
T3	M22 1TJ		5 of 7	Public Trnspt	5	1.3	676
T1	M4 4AJ		5 of 7	Public Trnspt	5	11.9	6188
T1	M23 1ED		5 of 7	Public Trnspt	5	5.1	2652
T1	BB2 1QW		5 of 7	Public Trnspt	5	55.4	28808
T2	M22 1RQ		5 of 7	Public Trnspt	5	2.9	1508
T2	SK14 4SQ		5 of 7	Public Trnspt	5	17.6	9152
T1	M22 9UW		5 of 7	Public Trnspt	5	2.7	1404
T1	M23 2UJ		5 of 7	Public Trnspt	5	3.3	1716
T1	SK16 4JQ		5 of 7	Public Trnspt	5	17.8	9256
T1	SG5 1XB		5 of 7	Public Trnspt	5	211.4	109928
T2	M13 9UT		5 of 7	Public Trnspt	5	11.2	5824
T1	M20 3WB		5 of 7	Public Trnspt	5	7.5	3900
T1	M22 1AN		5 of 7	Public Trnspt	5	1.4	728
T2	M19 2EA		5 of 7	Public Trnspt	5	13.9	7228
T1	M22 1QW		5 of 7	Public Trnspt	5	1.2	624
T2	SK2 7LW		5 of 7	Public Trnspt	5	8.5	4420
T1	OL5 0DA		5 of 7	Public Trnspt	5	21.1	10972
T2	M16 8HG		5 of 7	Public Trnspt	5	13.6	7072
T3	M22 5LF		5 of 7	Public Trnspt	5	1.6	832
T1	M6 6HE		5 of 7	Public Trnspt	5	13.6	7072
T3	WN3 5UE		5 of 7	Public Trnspt	5	34.1	17732
T1	M22 8LZ		5 of 7	Public Trnspt	5	3.3	1716
T1	M22 5QW		5 of 7	Public Trnspt	5	2.4	1248
T1	M20 2NL		5 of 7	Public Trnspt	5	5.6	2912
T1	M16 8AP		5 of 7	Public Trnspt	5	13.7	7124
T2	M19 2SA		Weekends	Public Trnspt	2	8.4	1747.2
T2	M16 0EQ		Weekends	Public Trnspt	2	9.9	2059.2

T1	BB10 2NS		Weekends	Public Trnspt	2	42.3	8798.4
T1	M19 2AW		Weekends	Public Trnspt	2	14.1	2932.8
T2	M12 5GY		Weekends	Public Trnspt	2	13.3	2766.4
T2	M19 1AU		Weekends	Public Trnspt	2	7	1456
T2	M23 1LW		Weekends	Public Trnspt	2	4.7	977.6
T2	M22 9NB		Weekends	Public Trnspt	2	2.6	540.8
T1	SK8 2EW		Weekends	Public Trnspt	2	7.5	1560
T2	BL3 3NW		Weekends	Public Trnspt	2	23.3	4846.4
T1	M20 6JZ		Weekends	Public Trnspt	2	6.1	1268.8
T3	M16 9GR		Weekends	Public Trnspt	2	10	2080
T3	M21 9PW		Weekends	Public Trnspt	2	9.3	1934.4

Appendix G; Cost of Weight Formula Data Set Calculations

Data Input						Per flight Calculations / Results							Annual Calculations / Results					
Airport Long Name	Flight Time	Total Weight (kg)	Percent of total weight	Number of Flights	Ave Weight per flight (kg)	Additional Fuel Burn (kg)	Direct tCO2e	WTT tCO2e	Total tCo2e	Total kgCO2e	Fuel Cost	Offset Cost	Additional Fuel Burn (tonnes)	Direct tCO2e	WTT tCO2e	Total tCo2e	Fuel Cost	Offset Cost
Dalaman (Mugla)	4.3	168,683.45	8.57	2014	83.76	10.7687	0.0343	0.0071	0.0413	41.3173	£7.06	£0.27	21.69	68.99	14.22	83.21	£14,227.40	£551.92
Sharm El Sheikh (Ophira)	5.5	95,998.09	4.88	1253	76.61	12.6654	0.0403	0.0083	0.0486	48.5944	£8.31	£0.32	15.87	50.48	10.41	60.89	£10,410.51	£403.85
Tenerife (Surreina Sofia)	4.5	73,088.61	3.72	1951	37.46	5.0699	0.0161	0.0033	0.0195	19.4520	£3.33	£0.13	9.89	31.46	6.49	37.95	£6,488.68	£251.71
Bodrum (Milas)	4.1	65,590.61	3.33	847	77.44	9.5779	0.0305	0.0063	0.0367	36.7487	£6.28	£0.24	8.11	25.81	5.32	31.13	£5,321.82	£206.45
Dublin	0.9	48,482.74	2.46	2791	17.37	0.4781	0.0015	0.0003	0.0018	1.8343	£0.31	£0.01	1.33	4.24	0.88	5.12	£875.29	£33.96
Orlando	9.2	46,664.44	2.37	816	57.19	15.8280	0.0503	0.0104	0.0607	60.7287	£10.38	£0.40	12.92	41.08	8.47	49.55	£8,472.64	£328.68
Dubai	7.6	43,923.23	2.23	2224	19.75	4.4943	0.0143	0.0029	0.0172	17.2436	£2.95	£0.11	10.00	31.79	6.55	38.35	£6,556.87	£254.36
Antalya	4.3	39,506.19	2.01	746	52.96	6.9077	0.0220	0.0045	0.0265	26.5034	£4.53	£0.18	5.15	16.39	3.38	19.77	£3,380.45	£131.14
Arrecife (Lanzarote) Canary Is	4.4	34,834.11	1.77	1215	28.67	3.7634	0.0120	0.0025	0.0144	14.4394	£2.47	£0.10	4.57	14.55	3.00	17.54	£2,999.58	£116.36
Monastir	3.2	32,464.52	1.65	407	79.77	7.7454	0.0246	0.0051	0.0297	29.7176	£5.08	£0.20	3.15	10.03	2.07	12.10	£2,067.96	£80.22
Larnaca	4.8	27,488.62	1.40	1006	27.32	3.8987	0.0124	0.0026	0.0150	14.9584	£2.56	£0.10	3.92	12.48	2.57	15.05	£2,572.86	£99.81
Toronto	8.0	26,999.28	1.37	815	33.13	7.9682	0.0253	0.0052	0.0306	30.5724	£5.23	£0.20	6.49	20.66	4.26	24.92	£4,260.12	£165.26
Stockholm (Arlanda Apt)	2.3	25,510.62	1.30	943	27.05	1.8942	0.0060	0.0012	0.0073	7.2676	£1.24	£0.05	1.79	5.68	1.17	6.85	£1,171.75	£45.46
Copenhagen (Kastrup)	1.9	24,333.31	1.24	1209	20.13	1.1562	0.0037	0.0008	0.0044	4.4360	£0.76	£0.03	1.40	4.45	0.92	5.36	£916.97	£35.57
Barbados (Bridgetown-Seawell)	8.7	23,772.25	1.21	398	59.73	15.5296	0.0494	0.0102	0.0596	59.5840	£10.19	£0.40	6.18	19.66	4.05	23.71	£4,054.59	£157.29
Hurghada	5.5	23,675.15	1.20	279	84.86	14.0660	0.0447	0.0092	0.0540	53.9684	£9.23	£0.36	3.92	12.48	2.57	15.06	£2,574.42	£99.87
Paphos	4.7	23,638.73	1.20	1040	22.73	3.1980	0.0102	0.0021	0.0123	12.2700	£2.10	£0.08	3.33	10.58	2.18	12.76	£2,181.79	£84.64
Zurich	1.9	23,546.51	1.20	1589	14.82	0.8605	0.0027	0.0006	0.0033	3.3016	£0.56	£0.02	1.37	4.35	0.90	5.25	£896.98	£34.80
Las Palmas	4.6	21,901.80	1.11	598	36.63	5.0407	0.0160	0.0033	0.0193	19.3400	£3.31	£0.13	3.01	9.59	1.98	11.57	£1,977.39	£76.71
Palma De Mallorca	2.6	21,333.07	1.08	1423	14.99	1.1685	0.0037	0.0008	0.0045	4.4834	£0.77	£0.03	1.66	5.29	1.09	6.38	£1,090.80	£42.31
New York/Newark Nj Apt	8.0	21,234.32	1.08	880	24.13	5.7633	0.0183	0.0038	0.0221	22.1128	£3.78	£0.15	5.07	16.13	3.33	19.46	£3,327.06	£129.07

Alicante	2.8	20,885.38	1.06	1423	14.68	1.2539	0.0040	0.0008	0.0048	4.8110	£0.82	£0.03	1.78	5.68	1.17	6.85	£1,170.51	£45.41
Cancun	10.7	20,751.77	1.05	374	55.49	17.8550	0.0568	0.0117	0.0685	68.5062	£11.71	£0.45	6.68	21.24	4.38	25.62	£4,380.63	£169.94
Malaga	3.0	20,616.75	1.05	1443	14.29	1.2931	0.0041	0.0008	0.0050	4.9615	£0.85	£0.03	1.87	5.94	1.22	7.16	£1,224.09	£47.49
Geneva	1.9	18,567.95	0.94	982	18.91	1.0811	0.0034	0.0007	0.0041	4.1481	£0.71	£0.03	1.06	3.38	0.70	4.07	£696.45	£27.02
Helsinki	2.8	18,367.41	0.93	1132	16.23	1.3531	0.0043	0.0009	0.0052	5.1915	£0.89	£0.03	1.53	4.87	1.00	5.88	£1,004.79	£38.98
Luxor	5.6	18,085.02	0.92	185	97.76	16.5488	0.0526	0.0109	0.0635	63.4946	£10.86	£0.42	3.06	9.74	2.01	11.75	£2,008.37	£77.91
Fuerteventura	4.4	17,889.25	0.91	578	30.95	4.0565	0.0129	0.0027	0.0156	15.5640	£2.66	£0.10	2.34	7.46	1.54	9.00	£1,538.10	£59.67
Philadelphia	7.8	17,821.66	0.91	434	41.06	9.6473	0.0307	0.0063	0.0370	37.0147	£6.33	£0.25	4.19	13.32	2.75	16.06	£2,746.62	£106.55
Goa	9.7	17,735.27	0.90	256	69.28	20.0907	0.0639	0.0132	0.0771	77.0841	£13.18	£0.51	5.14	16.36	3.37	19.73	£3,373.96	£130.88
Abu Dhabi	7.2	16,825.07	0.86	759	22.17	4.7694	0.0152	0.0031	0.0183	18.2992	£3.13	£0.12	3.62	11.52	2.37	13.89	£2,374.70	£92.12
Marrakech	3.8	16,759.57	0.85	324	51.73	5.8444	0.0186	0.0038	0.0224	22.4237	£3.83	£0.15	1.89	6.02	1.24	7.27	£1,242.19	£48.19
Istanbul	4.0	16,676.20	0.85	876	19.04	2.3033	0.0073	0.0015	0.0088	8.8372	£1.51	£0.06	2.02	6.42	1.32	7.74	£1,323.59	£51.35
Faro	3.0	16,371.43	0.83	892	18.35	1.6660	0.0053	0.0011	0.0064	6.3921	£1.09	£0.04	1.49	4.73	0.97	5.70	£974.87	£37.82
Izmir Adnan Menderes	3.8	16,172.30	0.82	491	32.94	3.7878	0.0120	0.0025	0.0145	14.5331	£2.48	£0.10	1.86	5.92	1.22	7.14	£1,220.04	£47.33
Malta	3.5	15,607.47	0.79	704	22.17	2.2962	0.0073	0.0015	0.0088	8.8101	£1.51	£0.06	1.62	5.14	1.06	6.20	£1,060.44	£41.14
Oslo [Metropolitan Area]	1.9	15,374.33	0.78	1260	12.20	0.7016	0.0022	0.0005	0.0027	2.6919	£0.46	£0.02	0.88	2.81	0.58	3.39	£579.92	£22.50
Paris (Char De Gaulle)	1.5	15,112.13	0.77	2733	5.53	0.2570	0.0008	0.0002	0.0010	0.9862	£0.17	£0.01	0.70	2.23	0.46	2.70	£460.83	£17.88
Islamabad Int	7.8	14,893.12	0.76	573	25.99	6.0569	0.0193	0.0040	0.0232	23.2393	£3.97	£0.15	3.47	11.04	2.28	13.32	£2,276.73	£88.32
New York/J. F. Kennedy	7.5	14,652.98	0.74	1387	10.56	2.3745	0.0076	0.0016	0.0091	9.1106	£1.56	£0.06	3.29	10.48	2.16	12.64	£2,160.53	£83.81
Jersey	1.5	14,171.09	0.72	767	18.48	0.8063	0.0026	0.0005	0.0031	3.0937	£0.53	£0.02	0.62	1.97	0.41	2.37	£405.71	£15.74
Frankfurt	1.8	13,955.37	0.71	2150	6.49	0.3416	0.0011	0.0002	0.0013	1.3107	£0.22	£0.01	0.73	2.34	0.48	2.82	£481.81	£18.69
Amsterdam (Schiphol)	1.4	13,797.67	0.70	2088	6.61	0.2743	0.0009	0.0002	0.0011	1.0523	£0.18	£0.01	0.57	1.82	0.38	2.20	£375.66	£14.57
Heraklion	3.9	13,667.73	0.69	486	28.12	3.2904	0.0105	0.0022	0.0126	12.6245	£2.16	£0.08	1.60	5.09	1.05	6.14	£1,049.03	£40.69
Atlanta	9.4	13,578.10	0.69	732	18.55	5.2253	0.0166	0.0034	0.0200	20.0483	£3.43	£0.13	3.82	12.17	2.51	14.68	£2,509.14	£97.34
Munich	2.0	13,447.41	0.68	1603	8.39	0.5039	0.0016	0.0003	0.0019	1.9332	£0.33	£0.01	0.81	2.57	0.53	3.10	£529.85	£20.55
Punta Cana	9.6	13,058.88	0.66	203	64.33	18.5858	0.0591	0.0122	0.0713	71.3102	£12.19	£0.47	3.77	12.00	2.47	14.48	£2,475.04	£96.01

Montego Bay	10.2	12,972.32	0.66	196	66.19	20.2279	0.0643	0.0133	0.0776	77.6103	£13.27	£0.51	3.96	12.61	2.60	15.21	£2,600.82	£100.89
Ibiza	2.7	12,423.89	0.63	596	20.85	1.7024	0.0054	0.0011	0.0065	6.5317	£1.12	£0.04	1.01	3.23	0.67	3.89	£665.59	£25.82
Gothenburg	1.8	12,276.77	0.62	962	12.76	0.7019	0.0022	0.0005	0.0027	2.6930	£0.46	£0.02	0.68	2.15	0.44	2.59	£442.95	£17.18
Sandford	9.5	12,196.04	0.62	368	33.14	9.4272	0.0300	0.0062	0.0362	36.1702	£6.18	£0.24	3.47	11.04	2.28	13.31	£2,275.80	£88.28
Vancouver	9.7	11,960.03	0.61	360	33.22	9.6345	0.0306	0.0063	0.0370	36.9655	£6.32	£0.25	3.47	11.03	2.27	13.31	£2,275.28	£88.26
Porto Plata	9.4	11,846.45	0.60	176	67.31	18.8998	0.0601	0.0124	0.0725	72.5146	£12.40	£0.48	3.33	10.58	2.18	12.76	£2,182.09	£84.65
Calgary	9.1	11,506.04	0.58	270	42.61	11.6629	0.0371	0.0076	0.0447	44.7482	£7.65	£0.30	3.15	10.02	2.07	12.08	£2,065.73	£80.14
Heathrow	1.1	11,333.81	0.58	4193	2.70	0.0878	0.0003	0.0001	0.0003	0.3368	£0.06	£0.00	0.37	1.17	0.24	1.41	£241.45	£9.37
Cork	1.3	10,275.78	0.52	564	18.22	0.6876	0.0022	0.0005	0.0026	2.6383	£0.45	£0.02	0.39	1.23	0.25	1.49	£254.42	£9.87
Corfu	3.1	10,192.58	0.52	434	23.49	2.1841	0.0069	0.0014	0.0084	8.3801	£1.43	£0.06	0.95	3.02	0.62	3.64	£621.83	£24.12
Rhodes	4.2	9,553.17	0.49	310	30.82	3.9068	0.0124	0.0026	0.0150	14.9897	£2.56	£0.10	1.21	3.85	0.79	4.65	£794.49	£30.82
Guernsey	1.6	9,181.35	0.47	839	10.94	0.5264	0.0017	0.0003	0.0020	2.0197	£0.35	£0.01	0.44	1.40	0.29	1.69	£289.72	£11.24
Chicago (O'Hare) Ill	8.7	8,651.30	0.44	540	16.02	4.1831	0.0133	0.0027	0.0160	16.0496	£2.74	£0.11	2.26	7.19	1.48	8.67	£1,481.81	£57.48
Beijing Capital International Airport	12.0	8,087.22	0.41	1741	4.65	1.6723	0.0053	0.0011	0.0064	6.4161	£1.10	£0.04	2.91	9.26	1.91	11.17	£1,909.88	£74.09
Budapest	2.9	8,080.45	0.41	503	16.06	1.4035	0.0045	0.0009	0.0054	5.3851	£0.92	£0.04	0.71	2.25	0.46	2.71	£463.12	£17.97
Bangkok	11.8	8,035.66	0.41	2046	3.93	1.3943	0.0044	0.0009	0.0053	5.3495	£0.91	£0.04	2.85	9.07	1.87	10.95	£1,871.34	£72.59
Prague	2.2	7,929.45	0.40	922	8.60	0.5783	0.0018	0.0004	0.0022	2.2188	£0.38	£0.01	0.53	1.70	0.35	2.05	£349.77	£13.57
Tel Aviv	5.2	7,855.57	0.40	434	18.10	2.8443	0.0090	0.0019	0.0109	10.9132	£1.87	£0.07	1.23	3.93	0.81	4.74	£809.80	£31.41
Holguin (Frank Pais)	9.8	7,848.84	0.40	170	46.17	13.5046	0.0430	0.0089	0.0518	51.8145	£8.86	£0.34	2.30	7.30	1.51	8.81	£1,506.04	£58.42
Varadero	9.9	7,833.60	0.40	133	58.90	17.5225	0.0557	0.0115	0.0672	67.2304	£11.49	£0.45	2.33	7.41	1.53	8.94	£1,528.80	£59.31
Banjul	6.6	7,664.09	0.39	89	86.11	17.0074	0.0541	0.0112	0.0653	65.2539	£11.16	£0.43	1.51	4.81	0.99	5.81	£992.96	£38.52
Lahore	7.7	7,398.14	0.38	246	30.07	6.9170	0.0220	0.0045	0.0265	26.5390	£4.54	£0.18	1.70	5.41	1.12	6.53	£1,116.23	£43.30
Connaught	1.1	7,358.70	0.37	283	26.00	0.8191	0.0026	0.0005	0.0031	3.1426	£0.54	£0.02	0.23	0.74	0.15	0.89	£152.06	£5.90
Belfast City	0.9	7,146.89	0.36	1704	4.19	0.1188	0.0004	0.0001	0.0005	0.4559	£0.08	£0.00	0.20	0.64	0.13	0.78	£132.82	£5.15
Singapore	14.0	7,068.46	0.36	1182	5.98	2.5122	0.0080	0.0016	0.0096	9.6388	£1.65	£0.06	2.97	9.45	1.95	11.39	£1,947.93	£75.57
Bombay	9.2	7,007.87	0.36	1200	5.84	1.6030	0.0051	0.0011	0.0062	6.1506	£1.05	£0.04	1.92	6.12	1.26	7.38	£1,261.92	£48.95

Zakinthos Is	3.7	6,984.16	0.35	326	21.42	2.3681	0.0075	0.0016	0.0091	9.0859	£1.55	£0.06	0.77	2.46	0.51	2.96	£506.43	£19.65
Mahon	2.3	6,905.19	0.35	469	14.72	1.0085	0.0032	0.0007	0.0039	3.8696	£0.66	£0.03	0.47	1.50	0.31	1.81	£310.29	£12.04
Doha	7.0	6,718.81	0.34	606	11.09	2.3208	0.0074	0.0015	0.0089	8.9044	£1.52	£0.06	1.41	4.47	0.92	5.40	£922.60	£35.79
Isle Of Man	0.8	6,668.73	0.34	1424	4.68	0.1108	0.0004	0.0001	0.0004	0.4253	£0.07	£0.00	0.16	0.50	0.10	0.61	£103.55	£4.02
Brussels (National)	1.4	6,433.53	0.33	1609	4.00	0.1678	0.0005	0.0001	0.0006	0.6437	£0.11	£0.00	0.27	0.86	0.18	1.04	£177.09	£6.87
Agadir	3.8	6,355.86	0.32	114	55.75	6.2968	0.0200	0.0041	0.0242	24.1597	£4.13	£0.16	0.72	2.28	0.47	2.75	£470.90	£18.27
Kefallinia	3.6	6,287.14	0.32	235	26.75	2.9284	0.0093	0.0019	0.0112	11.2356	£1.92	£0.07	0.69	2.19	0.45	2.64	£451.44	£17.51
Cunagua	10.8	6,059.26	0.31	80	75.74	24.5400	0.0781	0.0161	0.0942	94.1551	£16.10	£0.62	1.96	6.24	1.29	7.53	£1,287.86	£49.96
Duesseldorf	1.4	5,992.98	0.30	1597	3.75	0.1539	0.0005	0.0001	0.0006	0.5903	£0.10	£0.00	0.25	0.78	0.16	0.94	£161.19	£6.25
Shanghai	11.7	5,956.04	0.30	1586	3.76	1.3137	0.0042	0.0009	0.0050	5.0405	£0.86	£0.03	2.08	6.63	1.37	7.99	£1,366.81	£53.02
Kos	4.2	5,727.80	0.29	268	21.37	2.6863	0.0085	0.0018	0.0103	10.3068	£1.76	£0.07	0.72	2.29	0.47	2.76	£472.27	£18.32
Mombasa	9.5	5,650.99	0.29	128	44.15	12.5946	0.0401	0.0083	0.0483	48.3228	£8.26	£0.32	1.61	5.13	1.06	6.19	£1,057.54	£41.02
Hong Kong	15.0	5,594.11	0.28	1807	3.10	1.3959	0.0044	0.0009	0.0054	5.3557	£0.92	£0.04	2.52	8.02	1.65	9.68	£1,654.66	£64.19
Gatwick	1.1	5,527.50	0.28	1605	3.44	0.1133	0.0004	0.0001	0.0004	0.4347	£0.07	£0.00	0.18	0.58	0.12	0.70	£119.28	£4.63
Taba	5.3	5,524.10	0.28	51	108.32	17.2145	0.0548	0.0113	0.0660	66.0484	£11.29	£0.44	0.88	2.79	0.58	3.37	£575.93	£22.34
Boa Vista	9.6	5,048.56	0.26	62	81.43	23.4514	0.0746	0.0154	0.0900	89.9782	£15.38	£0.60	1.45	4.63	0.95	5.58	£953.81	£37.00
Sal	2.4	5,013.77	0.25	65	77.13	5.6309	0.0179	0.0037	0.0216	21.6045	£3.69	£0.14	0.37	1.16	0.24	1.40	£240.10	£9.31
Marsa Alam	5.7	4,867.48	0.25	62	78.51	13.4608	0.0428	0.0088	0.0516	51.6464	£8.83	£0.34	0.83	2.65	0.55	3.20	£547.48	£21.24
Delhi	8.5	4,797.89	0.24	1093	4.39	1.1238	0.0036	0.0007	0.0043	4.3116	£0.74	£0.03	1.23	3.91	0.81	4.71	£805.74	£31.26
Keflavik	2.6	4,650.60	0.24	215	21.63	1.6764	0.0053	0.0011	0.0064	6.4319	£1.10	£0.04	0.36	1.15	0.24	1.38	£236.44	£9.17
Bourgas	3.4	4,580.97	0.23	187	24.50	2.4865	0.0079	0.0016	0.0095	9.5401	£1.63	£0.06	0.46	1.48	0.30	1.78	£305.02	£11.83
Funchal	4.0	4,500.43	0.23	198	22.73	2.7244	0.0087	0.0018	0.0105	10.4529	£1.79	£0.07	0.54	1.72	0.35	2.07	£353.86	£13.73
Rome (Leo. Da Vinci)	2.4	4,403.93	0.22	724	6.08	0.4410	0.0014	0.0003	0.0017	1.6920	£0.29	£0.01	0.32	1.02	0.21	1.23	£209.45	£8.13
Basel	1.9	4,334.69	0.22	448	9.68	0.5641	0.0018	0.0004	0.0022	2.1643	£0.37	£0.01	0.25	0.80	0.17	0.97	£165.78	£6.43
Male International	12.6	4,206.65	0.21	397	10.60	4.0000	0.0127	0.0026	0.0153	15.3473	£2.62	£0.10	1.59	5.05	1.04	6.09	£1,041.74	£40.41
Athens	3.8	4,150.30	0.21	763	5.44	0.6119	0.0019	0.0004	0.0023	2.3479	£0.40	£0.02	0.47	1.49	0.31	1.79	£306.29	£11.88

Skiathos	3.8	4,134.98	0.21	123	33.62	3.7820	0.0120	0.0025	0.0145	14.5107	£2.48	£0.10	0.47	1.48	0.31	1.78	£305.16	£11.84
Galway Ireland	1.1	4,099.96	0.21	395	10.38	0.3321	0.0011	0.0002	0.0013	1.2744	£0.22	£0.01	0.13	0.42	0.09	0.50	£86.07	£3.34
Preveza/Levkas	3.2	4,099.33	0.21	108	37.96	3.6818	0.0117	0.0024	0.0141	14.1264	£2.42	£0.09	0.40	1.26	0.26	1.53	£260.85	£10.12
Las Vegas	10.1	4,024.76	0.20	323	12.46	3.7880	0.0120	0.0025	0.0145	14.5338	£2.48	£0.10	1.22	3.89	0.80	4.69	£802.63	£31.14
Barcelona	2.1	3,986.95	0.20	537	7.42	0.4566	0.0015	0.0003	0.0018	1.7519	£0.30	£0.01	0.25	0.78	0.16	0.94	£160.85	£6.24
Hamburg	1.6	3,983.11	0.20	898	4.44	0.2107	0.0007	0.0001	0.0008	0.8084	£0.14	£0.01	0.19	0.60	0.12	0.73	£124.11	£4.81
Belfast International	0.8	3,669.98	0.19	802	4.58	0.1098	0.0003	0.0001	0.0004	0.4214	£0.07	£0.00	0.09	0.28	0.06	0.34	£57.78	£2.24
Southampton	1.0	3,642.58	0.19	1220	2.99	0.0906	0.0003	0.0001	0.0003	0.3476	£0.06	£0.00	0.11	0.35	0.07	0.42	£72.50	£2.81
Murcia	2.8	3,528.78	0.18	232	15.21	1.2851	0.0041	0.0008	0.0049	4.9308	£0.84	£0.03	0.30	0.95	0.20	1.14	£195.59	£7.59
Waterford Ireland	0.9	3,527.73	0.18	240	14.70	0.4042	0.0013	0.0003	0.0016	1.5509	£0.27	£0.01	0.10	0.31	0.06	0.37	£63.64	£2.47
Milan (Malpensa Apt)	1.8	3,470.20	0.18	543	6.39	0.3451	0.0011	0.0002	0.0013	1.3241	£0.23	£0.01	0.19	0.60	0.12	0.72	£122.93	£4.77
Naples	2.6	3,451.53	0.18	181	19.07	1.4969	0.0048	0.0010	0.0057	5.7434	£0.98	£0.04	0.27	0.86	0.18	1.04	£177.74	£6.90
Dubrovnik	3.1	3,393.15	0.17	116	29.25	2.6853	0.0085	0.0018	0.0103	10.3028	£1.76	£0.07	0.31	0.99	0.20	1.20	£204.34	£7.93
Sofia	3.3	3,268.21	0.17	337	9.70	0.9737	0.0031	0.0006	0.0037	3.7360	£0.64	£0.02	0.33	1.04	0.22	1.26	£215.26	£8.35
Edinburgh	1.0	3,249.13	0.17	1589	2.04	0.0621	0.0002	0.0000	0.0002	0.2384	£0.04	£0.00	0.10	0.31	0.06	0.38	£64.78	£2.51
Tripoli	4.0	3,146.15	0.16	345	9.12	1.0943	0.0035	0.0007	0.0042	4.1987	£0.72	£0.03	0.38	1.20	0.25	1.45	£247.66	£9.61
Cologne	1.4	3,022.33	0.15	499	6.06	0.2544	0.0008	0.0002	0.0010	0.9760	£0.17	£0.01	0.13	0.40	0.08	0.49	£83.27	£3.23
Aruba	9.7	2,883.55	0.15	61	47.27	13.7087	0.0436	0.0090	0.0526	52.5975	£8.99	£0.35	0.84	2.66	0.55	3.21	£548.57	£21.28
Bergen (Flesland)	1.7	2,836.55	0.14	734	3.86	0.1990	0.0006	0.0001	0.0008	0.7636	£0.13	£0.01	0.15	0.46	0.10	0.56	£95.83	£3.72
Venice(Marco Polo)	2.0	2,751.97	0.14	395	6.97	0.4250	0.0014	0.0003	0.0016	1.6306	£0.28	£0.01	0.17	0.53	0.11	0.64	£110.12	£4.27
Guangzhou	11.7	2,664.43	0.14	554	4.81	1.6929	0.0054	0.0011	0.0065	6.4954	£1.11	£0.04	0.94	2.98	0.62	3.60	£615.25	£23.87
Thira	4.0	2,568.46	0.13	64	40.13	4.8493	0.0154	0.0032	0.0186	18.6058	£3.18	£0.12	0.31	0.99	0.20	1.19	£203.59	£7.90
Verona	2.0	2,560.44	0.13	200	12.80	0.7489	0.0024	0.0005	0.0029	2.8735	£0.49	£0.02	0.15	0.48	0.10	0.57	£98.26	£3.81
Santa Cruz De La Palma	4.5	2,429.43	0.12	54	44.99	6.1168	0.0195	0.0040	0.0235	23.4690	£4.01	£0.16	0.33	1.05	0.22	1.27	£216.68	£8.41
Nice	2.4	2,423.87	0.12	237	10.23	0.7415	0.0024	0.0005	0.0028	2.8449	£0.49	£0.02	0.18	0.56	0.12	0.67	£115.28	£4.47
Kuala Lumpur	13.1	2,380.95	0.12	832	2.86	1.1232	0.0036	0.0007	0.0043	4.3096	£0.74	£0.03	0.93	2.97	0.61	3.59	£613.05	£23.78

Glasgow	0.8	2,246.54	0.11	907	2.48	0.0619	0.0002	0.0000	0.0002	0.2376	£0.04	£0.00	0.06	0.18	0.04	0.22	£36.84	£1.43
Aberdeen	1.0	2,204.49	0.11	1058	2.08	0.0625	0.0002	0.0000	0.0002	0.2398	£0.04	£0.00	0.07	0.21	0.04	0.25	£43.38	£1.68
Chambery/Airx Les Bain	1.7	2,200.86	0.11	104	21.16	1.0475	0.0033	0.0007	0.0040	4.0191	£0.69	£0.03	0.11	0.35	0.07	0.42	£71.47	£2.77
Billund	1.7	2,194.83	0.11	598	3.67	0.1835	0.0006	0.0001	0.0007	0.7041	£0.12	£0.00	0.11	0.35	0.07	0.42	£71.99	£2.79
Marsa Matrum (Mersa Matruh)	4.5	2,169.86	0.11	32	67.81	9.0524	0.0288	0.0059	0.0347	34.7321	£5.94	£0.23	0.29	0.92	0.19	1.11	£190.03	£7.37
Grenoble	1.8	2,142.42	0.11	92	23.29	1.2459	0.0040	0.0008	0.0048	4.7801	£0.82	£0.03	0.11	0.36	0.08	0.44	£75.19	£2.92
Stavanger	1.6	2,110.56	0.11	620	3.40	0.1583	0.0005	0.0001	0.0006	0.6073	£0.10	£0.00	0.10	0.31	0.06	0.38	£64.38	£2.50
Innsbruck	2.2	2,045.69	0.10	106	19.30	1.2544	0.0040	0.0008	0.0048	4.8130	£0.82	£0.03	0.13	0.42	0.09	0.51	£87.23	£3.38
Reus	2.3	2,035.21	0.10	212	9.60	0.6630	0.0021	0.0004	0.0025	2.5438	£0.43	£0.02	0.14	0.45	0.09	0.54	£92.20	£3.58
Tenerife (Norte Los Rodeos) Sp	4.0	2,028.80	0.10	70	28.98	3.4924	0.0111	0.0023	0.0134	13.3998	£2.29	£0.09	0.24	0.78	0.16	0.94	£160.37	£6.22
Hanover	1.6	2,025.86	0.10	427	4.74	0.2254	0.0007	0.0001	0.0009	0.8647	£0.15	£0.01	0.10	0.31	0.06	0.37	£63.13	£2.45
Johannesburg	11.5	1,998.56	0.10	949	2.11	0.7255	0.0023	0.0005	0.0028	2.7836	£0.48	£0.02	0.69	2.19	0.45	2.64	£451.66	£17.52
Inverness	1.4	1,995.50	0.10	527	3.79	0.1629	0.0005	0.0001	0.0006	0.6251	£0.11	£0.00	0.09	0.27	0.06	0.33	£56.33	£2.19
Kittila	3.2	1,985.92	0.10	65	30.55	2.9352	0.0093	0.0019	0.0113	11.2619	£1.93	£0.07	0.19	0.61	0.13	0.73	£125.16	£4.86
Thessaloniki	3.5	1,926.71	0.10	297	6.49	0.6812	0.0022	0.0004	0.0026	2.6135	£0.45	£0.02	0.20	0.64	0.13	0.78	£132.71	£5.15
Shannon	1.4	1,922.83	0.10	201	9.57	0.4066	0.0013	0.0003	0.0016	1.5599	£0.27	£0.01	0.08	0.26	0.05	0.31	£53.61	£2.08
Salzburg	2.3	1,904.45	0.10	150	12.70	0.8729	0.0028	0.0006	0.0033	3.3490	£0.57	£0.02	0.13	0.42	0.09	0.50	£85.89	£3.33
Almeria	2.8	1,839.07	0.09	124	14.83	1.2637	0.0040	0.0008	0.0048	4.8487	£0.83	£0.03	0.16	0.50	0.10	0.60	£102.80	£3.99
Paderborn	1.5	1,822.10	0.09	164	11.11	0.5111	0.0016	0.0003	0.0020	1.9609	£0.34	£0.01	0.08	0.27	0.05	0.32	£54.98	£2.13
Hyderabad	9.8	1,761.66	0.09	346	5.09	1.4918	0.0047	0.0010	0.0057	5.7238	£0.98	£0.04	0.52	1.64	0.34	1.98	£338.60	£13.14
Chania Soudha Crete	3.9	1,708.98	0.09	53	32.24	3.8049	0.0121	0.0025	0.0146	14.5986	£2.50	£0.10	0.20	0.64	0.13	0.77	£132.29	£5.13
Cairo	4.9	1,708.57	0.09	612	2.79	0.4076	0.0013	0.0003	0.0016	1.5639	£0.27	£0.01	0.25	0.79	0.16	0.96	£163.64	£6.35
Colombo(Bandaranaike)	11.0	1,656.71	0.08	460	3.60	1.1849	0.0038	0.0008	0.0045	4.5463	£0.78	£0.03	0.55	1.73	0.36	2.09	£357.56	£13.87
Toulouse	2.1	1,597.01	0.08	251	6.36	0.4084	0.0013	0.0003	0.0016	1.5671	£0.27	£0.01	0.10	0.33	0.07	0.39	£67.25	£2.61
Madras	10.4	1,585.11	0.08	375	4.23	1.3125	0.0042	0.0009	0.0050	5.0357	£0.86	£0.03	0.49	1.57	0.32	1.89	£322.87	£12.52

Bangalore	10.2	1,582.82	0.08	438	3.61	1.1004	0.0035	0.0007	0.0042	4.2219	£0.72	£0.03	0.48	1.53	0.32	1.85	£316.17	£12.27
Puttaparthi	10.1	1,577.98	0.08	24	65.75	19.8234	0.0631	0.0130	0.0761	76.0583	£13.00	£0.50	0.48	1.51	0.31	1.83	£312.10	£12.11
Mauritius	12.3	1,550.87	0.08	463	3.35	1.2360	0.0039	0.0008	0.0047	4.7423	£0.81	£0.03	0.57	1.82	0.38	2.20	£375.41	£14.56
Trondheim (Vaernes)	2.0	1,548.56	0.08	349	4.44	0.2618	0.0008	0.0002	0.0010	1.0044	£0.17	£0.01	0.09	0.29	0.06	0.35	£59.94	£2.33
Gibraltar	3.0	1,539.08	0.08	176	8.74	0.7794	0.0025	0.0005	0.0030	2.9905	£0.51	£0.02	0.14	0.44	0.09	0.53	£89.99	£3.49
Kochi	10.4	1,536.66	0.08	274	5.61	1.7442	0.0055	0.0011	0.0067	6.6920	£1.14	£0.04	0.48	1.52	0.31	1.83	£313.50	£12.16
Tabibuga	17.0	1,477.08	0.08	13	113.62	57.8335	0.1840	0.0379	0.2219	221.8954	£37.94	£1.47	0.75	2.39	0.49	2.88	£493.20	£19.13
Split	2.8	1,464.53	0.07	48	30.51	2.5934	0.0082	0.0017	0.0100	9.9505	£1.70	£0.07	0.12	0.40	0.08	0.48	£81.66	£3.17
Ercan	3.7	1,454.45	0.07	141	10.32	1.1501	0.0037	0.0008	0.0044	4.4129	£0.75	£0.03	0.16	0.52	0.11	0.62	£106.38	£4.13
Terceira	3.4	1,411.45	0.07	45	31.37	3.1836	0.0101	0.0021	0.0122	12.2148	£2.09	£0.08	0.14	0.46	0.09	0.55	£93.98	£3.65
Stuttgart	1.8	1,404.52	0.07	409	3.43	0.1854	0.0006	0.0001	0.0007	0.7115	£0.12	£0.00	0.08	0.24	0.05	0.29	£49.75	£1.93
Exeter	1.0	1,389.33	0.07	466	2.98	0.0894	0.0003	0.0001	0.0003	0.3432	£0.06	£0.00	0.04	0.13	0.03	0.16	£27.34	£1.06
Lagos	6.6	1,383.78	0.07	506	2.73	0.5442	0.0017	0.0004	0.0021	2.0880	£0.36	£0.01	0.28	0.88	0.18	1.06	£180.64	£7.01
Mitilini	3.6	1,332.56	0.07	51	26.13	2.8350	0.0090	0.0019	0.0109	10.8771	£1.86	£0.07	0.14	0.46	0.09	0.55	£94.85	£3.68
Santa Clara	10.4	1,280.42	0.07	19	67.39	21.0259	0.0669	0.0138	0.0807	80.6721	£13.79	£0.54	0.40	1.27	0.26	1.53	£262.07	£10.17
Kerry County (Killarney)	1.2	1,275.53	0.06	131	9.74	0.3359	0.0011	0.0002	0.0013	1.2889	£0.22	£0.01	0.04	0.14	0.03	0.17	£28.87	£1.12
Pisa	2.5	1,231.87	0.06	134	9.19	0.6895	0.0022	0.0005	0.0026	2.6454	£0.45	£0.02	0.09	0.29	0.06	0.35	£60.61	£2.35
Kavalla	3.3	1,192.20	0.06	37	32.22	3.1738	0.0101	0.0021	0.0122	12.1774	£2.08	£0.08	0.12	0.37	0.08	0.45	£77.04	£2.99
Newquay	1.2	1,188.83	0.06	154	7.72	0.2702	0.0009	0.0002	0.0010	1.0367	£0.18	£0.01	0.04	0.13	0.03	0.16	£27.30	£1.06
Antwerp	1.6	1,181.46	0.06	434	2.72	0.1293	0.0004	0.0001	0.0005	0.4961	£0.08	£0.00	0.06	0.18	0.04	0.22	£36.81	£1.43
Tokyo (Narita Apt)	11.7	1,163.74	0.06	585	1.99	0.6972	0.0022	0.0005	0.0027	2.6752	£0.46	£0.02	0.41	1.30	0.27	1.56	£267.58	£10.38
Mykonos	3.9	1,144.73	0.06	39	29.35	3.4489	0.0110	0.0023	0.0132	13.2326	£2.26	£0.09	0.13	0.43	0.09	0.52	£88.24	£3.42
Seoul (Incheon)	10.9	1,118.78	0.06	486	2.30	0.7516	0.0024	0.0005	0.0029	2.8838	£0.49	£0.02	0.37	1.16	0.24	1.40	£239.63	£9.30
Calcutta	10.0	1,063.22	0.05	239	4.45	1.3346	0.0042	0.0009	0.0051	5.1205	£0.88	£0.03	0.32	1.01	0.21	1.22	£209.24	£8.12
Dominica Melville Hall Apt	8.3	1,051.20	0.05	18	58.40	14.4832	0.0461	0.0095	0.0556	55.5690	£9.50	£0.37	0.26	0.83	0.17	1.00	£171.02	£6.63
Perth	19.3	1,000.15	0.05	602	1.66	0.9636	0.0031	0.0006	0.0037	3.6971	£0.63	£0.02	0.58	1.85	0.38	2.23	£380.54	£14.76

Moscow (Domodedevo)	6.2	976.02	0.05	381	2.56	0.4739	0.0015	0.0003	0.0018	1.8183	£0.31	£0.01	0.18	0.57	0.12	0.69	£118.45	£4.59
Sydney	20.6	974.40	0.05	902	1.08	0.6687	0.0021	0.0004	0.0026	2.5656	£0.44	£0.02	0.60	1.92	0.40	2.31	£395.67	£15.35
Manila Ninoy Aquino International Apt	13.2	941.70	0.05	439	2.15	0.8495	0.0027	0.0006	0.0033	3.2592	£0.56	£0.02	0.37	1.19	0.24	1.43	£244.63	£9.49
Minsk	2.7	915.25	0.05	100	9.15	0.7468	0.0024	0.0005	0.0029	2.8655	£0.49	£0.02	0.07	0.24	0.05	0.29	£48.99	£1.90
Capetown	12.2	913.82	0.05	439	2.08	0.7606	0.0024	0.0005	0.0029	2.9183	£0.50	£0.02	0.33	1.06	0.22	1.28	£219.04	£8.50
Bahrain	6.7	905.57	0.05	465	1.95	0.3903	0.0012	0.0003	0.0015	1.4974	£0.26	£0.01	0.18	0.58	0.12	0.70	£119.05	£4.62
Muscat	7.6	901.41	0.05	423	2.13	0.4827	0.0015	0.0003	0.0019	1.8519	£0.32	£0.01	0.20	0.65	0.13	0.78	£133.93	£5.20
Bucharest Otopeni	3.1	893.44	0.05	429	2.08	0.1949	0.0006	0.0001	0.0007	0.7479	£0.13	£0.00	0.08	0.27	0.05	0.32	£54.86	£2.13
Chengdu	10.3	892.17	0.05	129	6.92	2.1371	0.0068	0.0014	0.0082	8.1994	£1.40	£0.05	0.28	0.88	0.18	1.06	£180.85	£7.02
Turin	1.8	888.82	0.05	130	6.84	0.3692	0.0012	0.0002	0.0014	1.4165	£0.24	£0.01	0.05	0.15	0.03	0.18	£31.49	£1.22
Norwich	1.0	864.59	0.04	363	2.38	0.0717	0.0002	0.0000	0.0003	0.2751	£0.05	£0.00	0.03	0.08	0.02	0.10	£17.08	£0.66
Vienna (Schwechat)	2.1	853.76	0.04	550	1.55	0.0987	0.0003	0.0001	0.0004	0.3788	£0.06	£0.00	0.05	0.17	0.04	0.21	£35.62	£1.38
Acapulco	11.1	851.36	0.04	31	27.46	9.1700	0.0292	0.0060	0.0352	35.1834	£6.02	£0.23	0.28	0.90	0.19	1.09	£186.48	£7.23
Kalamata	3.5	829.09	0.04	40	20.73	2.1888	0.0070	0.0014	0.0084	8.3980	£1.44	£0.06	0.09	0.28	0.06	0.34	£57.43	£2.23
Sulaymaniyah	5.4	827.13	0.04	43	19.24	3.0989	0.0099	0.0020	0.0119	11.8897	£2.03	£0.08	0.13	0.42	0.09	0.51	£87.41	£3.39
Nairobi	8.8	801.81	0.04	341	2.35	0.6222	0.0020	0.0004	0.0024	2.3871	£0.41	£0.02	0.21	0.67	0.14	0.81	£139.18	£5.40
Bordeaux	1.8	784.71	0.04	139	5.65	0.3077	0.0010	0.0002	0.0012	1.1805	£0.20	£0.01	0.04	0.14	0.03	0.16	£28.06	£1.09
St.Petersburg	2.9	781.48	0.04	284	2.75	0.2380	0.0008	0.0002	0.0009	0.9132	£0.16	£0.01	0.07	0.22	0.04	0.26	£44.34	£1.72
Kiev (Borispol)	3.1	763.99	0.04	325	2.35	0.2198	0.0007	0.0001	0.0008	0.8433	£0.14	£0.01	0.07	0.23	0.05	0.27	£46.86	£1.82
Melbourne Vic.	20.6	753.34	0.04	671	1.12	0.6938	0.0022	0.0005	0.0027	2.6621	£0.46	£0.02	0.47	1.48	0.31	1.79	£305.41	£11.85
Lisbon	3.0	744.98	0.04	195	3.82	0.3454	0.0011	0.0002	0.0013	1.3253	£0.23	£0.01	0.07	0.21	0.04	0.26	£44.19	£1.71
Catania	3.4	725.24	0.04	45	16.12	1.6318	0.0052	0.0011	0.0063	6.2609	£1.07	£0.04	0.07	0.23	0.05	0.28	£48.17	£1.87
Lyon	1.6	712.18	0.04	328	2.17	0.1031	0.0003	0.0001	0.0004	0.3957	£0.07	£0.00	0.03	0.11	0.02	0.13	£22.19	£0.86
Moscow (Sheremetyevo Apt)	3.4	703.99	0.04	282	2.50	0.2559	0.0008	0.0002	0.0010	0.9818	£0.17	£0.01	0.07	0.23	0.05	0.28	£47.34	£1.84

Appendix H; Materiality Testing of increased fuel burn to account for greater distances.

	COW Formula	5% Additional Fuel Burn	15% Additional Fuel Burn	25% Additional Fuel Burn	50% Additional Fuel Burn
FUEL BURN	3%	3%	3%	3%	3%
Additional Fuel burn in the data set (tonnes)	284.87	299.11	327.60	356.08	427.30
Percentage of total weight accounted for in the sample	97.23	97.23	97.23	97.23	97.23
Additional Fuel burn grossed up to 100% of weight (tonnes)	292.98	307.63	336.93	366.23	439.47
Additional Fuel per Passenger - 17873188 in 2010	0.00002	0.00002	0.00002	0.00002	0.00002
Additional Fuel burn in 2014 - 22055258 passengers	361.53	379.61	415.76	451.92	542.30
CARBON					
Carbon Conversion Factor - Direct Fuel Bun Emissions (kgCO2e/kg fuel)	3.1497	3.1497	3.1497	3.1497	3.1497
Carbon Conversion Factor - WTT Emissions (kgCO2e/kg fuel)	0.6493	0.6493	0.6493	0.6493	0.6493
Total Direct Fuel Burn Emissions (tCO2e)	1,138.72	1,195.66	1,309.53	1,423.41	1,708.09
Total Direct WTT Emissions (tCO2e)	234.74	246.48	269.96	293.43	352.12
Total Emissions (tCO2e)	1,373.47	1,442.14	1,579.49	1,716.84	2,060.20
Additional Carbon Per Passenger	0.00008	0.00008	0.00009	0.00010	0.00012
Additional tCO2e Globally (based on 3,100,000,000 pax)	238,220.04	250,131.04	273,953.04	297,775.05	357,330.06
Percentage contribution to global aviation CO2 emissions	0.03	0.04	0.04	0.04	0.05
FUEL COST					
Additional Fuel Cost at Manchester (GBP)	237,166.40	249,024.72	272,741.36	296,458.00	355,749.60
Additional Fuel per passenger (tCO2e / passenger)	0.013	0.014	0.015	0.017	0.020
Global Fuel Cost (GBP)	41,135,126.34	43,191,882.66	47,305,395.29	51,418,907.93	61,702,689.51
Airline Industry spend on Jet Fuel per year GBP	134,511,410,640.00	134,511,410,640.00	134,511,410,640.00	134,511,410,640.00	134,511,410,640.00
Percentage contribution to global aviation fuel costs (£705m pa)	0.03	0.03	0.04	0.04	0.05

Appendix I; Cost of Weight formula materiality testing

	Research Data	Materiality Testing			
Cost of Weight Formula Percentage	3%	3.25%	3.50%	3.75%	4%
FUEL BURN					
Additional Fuel burn in the data set (tonnes)	284.87	308.60	332.34	356.08	379.82
Percentage of total weight accounted for in the sample	97.23	97.23	97.23	97.23	97.23
Additional Fuel burn grossed up to 100% of weight (tonnes)	292.98	317.40	341.81	366.23	390.64
Additional Fuel per Passenger - 17873188 in 2010	0.00002	0.00002	0.00002	0.00002	0.00002
Additional Fuel burn in 2014 - 22055258 passengers	**361.53**	**391.66**	**421.79**	**451.92**	**482.05**
CARBON					
Carbon Conversion Factor - Direct Fuel Bun Emissions (kgCO2e/kg fuel)	3.1497	3.1497	3.1497	3.1497	3.1497
Carbon Conversion Factor - WTT Emissions (kgCO2e/kg fuel)	0.6493	0.6493	0.6493	0.6493	0.6493
Total Direct Fuel Burn Emissions (tCO2e)	1,138.72	1,233.62	1,328.51	1,423.41	1,518.30
Total Direct WTT Emissions (tCO2e)	234.74	254.31	273.87	293.43	312.99
Total Emissions (tCO2e)	1,373.47	1,487.92	1,602.38	1,716.84	1,831.29
Additional Carbon Per Passenger	0.00008	0.00008	0.00009	0.00010	0.00010
Additional tCO2e Globally (based on 3,100,000,000 pax)	238,220.04	258,071.71	277,923.38	297,775.05	317,626.72
Percentage contribution to global aviation CO2 emissions	**0.03**	**0.04**	**0.04**	**0.04**	**0.05**
FUEL COST					
Additional Fuel Cost at Manchester (GBP)	237,166.40	256,930.27	276,694.14	296,458.00	316,221.87
Additional Fuel per passenger (tCO2e / passenger)	0.013	0.014	0.015	0.017	0.018
Global Fuel Cost (GBP)	41,135,126.34	44,563,053.54	47,990,980.73	51,418,907.93	54,846,835.12
Airline Industry spend on Jet Fuel per year GBP	134,511,410,640.00	134,511,410,640.00	134,511,410,640.00	134,511,410,640.00	134,511,410,640.00
Percentage contribution to global aviation fuel costs (£705m pa)	**0.03**	**0.03**	**0.04**	**0.04**	**0.04**